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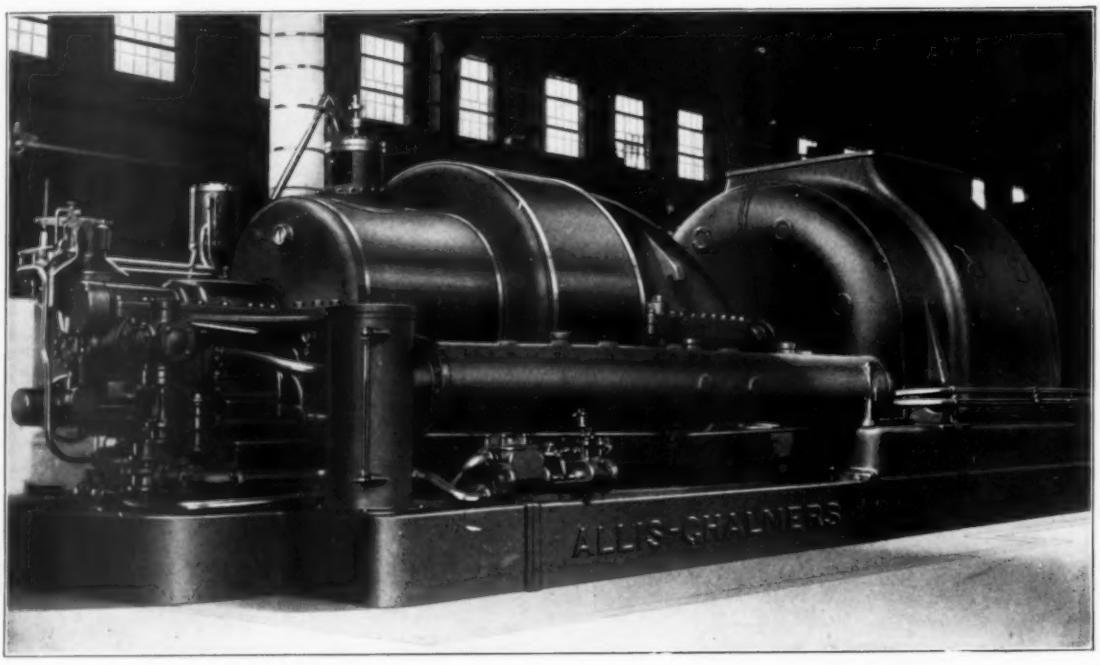

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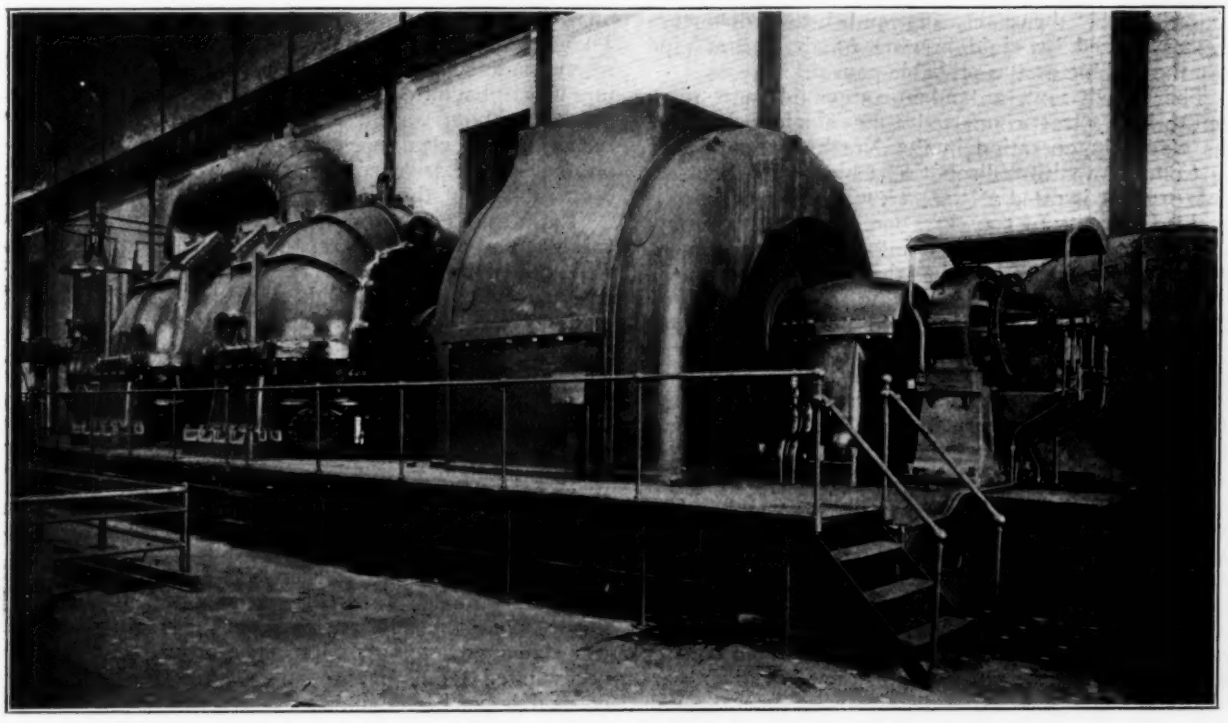


35,000-kw. Tandem Compound Turbogenerator at Northwest Station of Commonwealth Edison Company.

Operating and Design Problems Involving Turbines of Large Capacity

Reliability, Feasibility and Efficiency of Large Units—Operating and Structural Features—Abstract of A. S. M. E. Paper

By J. F. JOHNSON

Engineer, Turbine Department, Westinghouse Electric & Manufacturing Co.

SIGNIFICANT in the development of the electric power industry is the concentration of generating capacity. This is favored, first, by growth of industrial load, which centers about the cities, and second by the economic advantages of the large central station over the smaller one. At the present time there are six districts in the United States in which the maximum sustained peak load on all companies is above 150,000 kw. and one of these has a peak of 800,000 kw. These large and growing loads have put it up to the manufacturers to design generating units with regard to their full-load characteristics, and without limitations of size. With the rapid increase of size there has been a feeling in some quarters that the limits of a good practice have been exceeded, and that safety and reliability had been sacrificed for economy.

OPERATING EXPERIENCE WITH NINE LARGE UNITS.

The first three of these units, of identical design, were sold to the Interborough Rapid Transit Company of New York. They are two-cylinder, cross-compound, pure-reaction type machines, rated at 30,000 kw. (maximum) with the highest efficiency at 25,000 kw., the high-pressure units operating at 1500 r.p.m. and the low-pressure at 750 r.p.m.

Since their installation in December, 1914, February and August, 1915, respectively, these units have operated on an average from 16 to 20 hr. per day, on fluctuating railway loads varying from 10,000 kw. to

30,000 kw. With the first and third no troubles of any sort have been experienced, and they have been ready at all times for any service within their designed capacity excepting when out of service for regular periodic inspection or ordinary maintenance. On the second the labyrinth packing on the balance pistons of high-pressure element has failed three times, requiring renewal of some parts. The cause of these failures, at first supposed to have been improper adjustment, was found to be due to excessive lost motion in the thrust bearing and heavy distortion stresses caused by rigid bracing of the steam pipe near the turbine as the probable causes.

The fourth unit, a tandem-compound, pure-reaction turbine direct-connected to a single generator, was placed in operation in the Northwest station of the Commonwealth Edison Co., Chicago, in September, 1917. It is rated at 30,000 kw. with an additional overload capacity of 5000 kw. operating at 1200 r.p.m. A few hours after being put into service, subsequent to completion of erection, the labyrinth packing on the low-pressure element failed, owing to buckling of the turbine cylinder, caused by rigid piping connections between the two surface condensers, which are bolted rigidly to the two exhaust openings on the turbine, preventing the condensers from translating with the turbine as its temperature increased. Temporary repairs were made locally and the unit put in service in about four weeks. It has been operating almost continuously ever since without trouble of any sort (except cracking of a copper expansion joint), carrying loads as high as 40,000 kw. In one instance it was kept on the line for 71 days and then taken off only in order to clean the condenser. Material for making permanent repairs to the labyrinth packing was shipped to the station within a few months after the accident, but the purchaser has not yet given permission to take the unit out of service long enough to install it.

The fifth unit, a 30,000-kw. pure-reaction, single-cylinder machine, was placed in operation in the Gold Street station of the Edison Electric Illuminating Co. of Brooklyn in October, 1917. With the exception of a few leaks in the oiling system and the breaking of a defective gear on the oil-pump drive, no trouble of any sort has been experienced. It has been available for service at all times, and has been operating almost continuously, except over Sundays and when necessary to clean the condensers, at average loads of approximately 23,000 kw. and peak loads as high as 32,000 kw.

In December, 1917, the sixth unit went into service at the Kent Avenue station of the Brooklyn Rapid Transit Co., a duplicate of the fifth machine. Just after installation some rebalancing of both turbine and generator rotors was necessary. After having been in service approximately ten months the thrust bearing overheated and wiped to some extent, but did not damage any other part of the machine. When opened for inspection it was found that the labyrinth packing strips, which were made of an aluminum alloy, were considerably corroded by the action of strong alkalis used at this plant for treating feed water; and two rows of blading in the high-pressure portion of the machine were found to have been damaged at some previous time, this having been caused probably by foreign matter or a defective blade. This machine was in regular service up to that time, carrying maximum loads as high as 31,000 kw. and an average of 25,000 kw.

The seventh unit is a 40,000-kw. cross-compound machine, installed in the Brunots Island station of the Duquesne Light Co., and was placed in service in December, 1917. The high-pressure element of this machine operates at 1800 r.p.m. and the low-pressure element at 1200 r.p.m. This unit has been in regular service carrying loads normally of from 30,000 kw. to 40,000 kw. with peaks as high as 50,000 kw. While operating the machine to correct the balance of one of the generators, the main bearing at the coupling end of the high-pressure turbine burned out, apparently owing to interruption of oil service to that bearing. This let the spindle down sufficiently to cause rather heavy blade rubs throughout the machine. The bearing was rebabbitted and the machine put back in service without any other work being done except rechecking the clearances and placing a balance weight on the spindle to correct for the weight which had been rubbed off the blades.

Later the generator was damaged by electrical trouble, and while this repair was being made both elements of the turbine were dismantled. The high-pressure rotor was returned to the shops, the damaged blading replaced and rebalanced. New blading was also installed in the stator to restore original clearances and original efficiencies. Inspection of the low-pressure element revealed several broken blades which were defective and had slightly damaged the rest of the blading in those rows, requiring replacement of approximately one and one-half rows of blading on each end of the machine.

The eighth unit, practically a duplicate of the seventh, rated at 45,000 kw. (maximum), was delivered to the Narragansett Electric Light Co. in Providence in January, 1918. In placing this machine in service the labyrinth packing on the high pressure was damaged, owing to improper adjustment, which necessitated temporary repairs. Since making them no trouble has been experienced except some distortion of the couplings caused by a series of violent short-circuits and some defective workmanship on the fitting of the coupling keys. Permanent repairs to the labyrinth packing have been made and new coupling parts are to be installed in the near future. In the meantime the old parts are operating satisfactorily without any evidence of distress. This machine operates on loads as low as 5000 kw. and has carried a peak load of 50,000 kw. for periods of from four to five minutes.

The ninth unit is a 70,000-kw., three-cylinder, cross-compound machine installed for the Interborough Rapid Transit Co. in New York. One low-pressure element was placed in service April, 1918, operating on high-pressure steam. The one high-pressure element was placed in service in August, operating in connection with the low-pressure element already installed, and the second low-pressure element was placed in service in October. Some intermittent vibration trouble appeared on the first low-pressure machine, caused by lack of sufficient clearance on one of the spindle rings, resulting in distortion during expansion. With this corrected, no further trouble was experienced except the breaking of a few defective blades on the intermediate stage of the second low-pressure element.

This unit is equipped with an automatic-control mechanism for cutting out of service either automatically or manually, either element without disturbing the other two. These features have been given a thorough tryout, which in so far as a demonstration goes has verified all expectations as to flexibility of operation of a multiple-unit set. In regular service

it has carried loads as high as 55,000 kw. with swings up to 61,000 kw.

While these records do not all show 100% perfection, they do show that in no instance has there been any evidence of inherent or basic defects in design or difficulties in construction or operation. The troubles experienced were of minor character, due to avoidable defects in detail design, construction, installation or operation, such as may be experienced with new designs of any size or sort. It is significant that, with one exception, no important part of any one of these units has ever been returned to the works for replacement, alteration or repair. The high-pressure rotor of the Duquesne Light Co. unit was returned to the shops for checking for truth and reblading. While most of them have not been subjected to any accurate steam consumption tests, definite reductions in station coal consumption rates were effected by their installation.

Problems of Turbine Design.

The greatest single problem is that of providing areas suitable to accommodate the enormous increase in volume of the steam while passing through the turbine. With steam supplied at the throttle at 250 lb. pressure and 150° F. superheat, the volume when exhausting to 28½-in. vacuum is 166½ times, and when exhausting to 29-in. vacuum is 241 times as large as it is at the entrance. This means that if the mean diameter and exit angle of all the rows of blading be the same and the ratio of blade speed to steam speed be the same in each, and if the height of the blades in the first stage be taken as 1 in., the last row would have to be approximately 14 ft. if designed for 28½-in. vacuum and 20 ft. if designed for 29-in. vacuum. It is here that the combining of conflicting factors begins. In the first stages the areas and blade heights should be kept large in order to reduce the losses; in the low-pressure stages they must be sacrificed on account of practicable limits of mechanical design. In single-cylinder machines where the blading is all on the same spindle the problem becomes doubly difficult.

The chief factor in the selection of the rotative speed is the design of the last row of blades with reference to height, diameter and exit angle, because this is the most important stage in the whole turbine. To secure the most satisfactory design and prevent the stresses or physical dimensions with the ever-present cost from becoming prohibitive, several compromise features are employed.

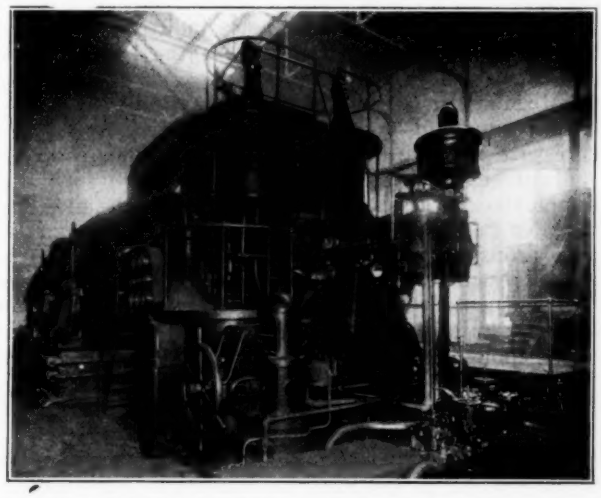
The first of these consists of increasing rotor diameter and blade heights until the safe limit of stress is reached, if necessary, keeping the blade height within approximately 25% of the rotor diameter as a limit of good practice. The materials of which the rotor and blades are made will, of course, determine the safe stresses, and on account of the great importance of safety and reliability in these parts only good quality of plain or 5% nickel low-carbon steels should be used, materials commercially available, of uniform quality, that do not require sensitive heat treatments.

Increasing the diameter not only permits increasing the blade height, but also steam speed, without materially affecting the efficiency, by reason of the increase in blade speed. There is, however, a slight falling off in efficiency with the higher speeds, though the ratio of blade to steam speed be kept practically constant, because, the actual velocity of the steam with reference to the blade being greater, the frictional losses will be greater.

The second compromise consists of increasing the area of the steam passage through the blades by changing the blade shape. This increases the angle between the direction of steam flow from the blade and the direction of the blade, and a slight impairment of efficiency results therefrom. This loss is, however, slight compared to the gain from the higher ratio of blade speed to steam resulting from the increased area.

The third compromise consists of permitting the steam speed to increase without a corresponding increase in blade speed, thereby decreasing the ratio of blade speed to steam speed and increasing the leaving losses. This compromise may properly be employed up to the point where the loss of efficiency will justify the increased expense of greater blade areas, which may necessitate dropping to a lower rotative speed or employing multiple stages.

Two more low-pressure stages in multiple in connection with a single high-pressure stage are used when the required areas cannot be obtained with a single stage at the rotative speed chosen and when it is more feasible to employ multiple stages than a lower rotative speed. Other considerations favoring multiple stages are reduced physical dimensions of the exhaust chambers, simplifying both the ribbing and bracing necessary to maintain the proper rigidity, and of the cylinder-supporting structure, including foundations, and limitations of shipping dimensions established by transportation companies.



Turbine Control Mechanism of 35,000-kw. Turbogenerator at Northwest Station.

Design of Higher-Pressure Stages.

The design of the higher stages usually involves only an equitable selection of diameters, blade speeds and steam speeds. Keeping these low results in low stresses and high efficiency but large number of stages and high cost, while keeping them high reduces the length, weight and cost but increases stresses and impairs efficiency.

If the steam volumes in the first stages are relatively small for the rotative speed employed, as would be occasioned by the use of high steam pressure or low rating, a double-velocity stage impulse element may often be employed to advantage, the advantages secured being reduction of length, increased diameter, reduced pressure and temperature inside the main

cylinder and adaptability for varying overload capacity.

Having fixed the rotative speed to secure proper design of the low-pressure stages, and the diameters and steam speeds of the high-pressure stages for highest economy, rotor length may become excessive, necessitating its division into two parts in order to maintain requisite reliability. These parts may be arranged either in tandem form, driving a single generator, or in cross-compound form, driving two generators. When arranged cross-compound it will often be found advantageous to increase the rotative speed of the high-pressure element, thereby gaining reduced physical dimensions, weight and cost without sacrifice of efficiency or reliability. The multi-cylinder construction is especially desirable in the employment of high steam pressures and superheats because the high-pressure turbine structure is small and there is less danger of stress complications resulting from wide temperature differences and no transmission of heat through the cylinder walls from high-pressure or low-pressure stages. A further advantage in these days of increasing steam conditions is that a unit may be designed for a given steam condition and later be redesigned for materially higher conditions, the redesign being entirely carried out in the high-pressure element.

In units of 60,000 kw. or larger the three-cylinder cross-compound construction employing one high-pressure and two low-pressure elements possesses the advantages of high efficiency and reliability without employing excessively large structures; and has greater flexibility than is possible with either of the other constructions. This flexibility, since it enables the high-pressure element to operate with either low-pressure element, or either of the three elements to operate alone, admirably adapts it for use in systems not yet large enough to permit employing a single unit of such large capacity. These units may be provided with a control mechanism by means of which either of the elements may be taken out of service automatically or manually, through operation of circuit breakers or automatic stop governor, the remaining ones continue to operate, carrying loads up to the maximum ratings of their generators. The low-pressure elements, when operating on high-pressure steam direct, may be made to carry loads for short periods considerably in excess of the rated capacities of their generators.

Reliability and general operative excellence of a large turbine are dependent largely upon the excellence of design of details such as the blading and blade fastenings, maintenance of clearances and alignments under all possible variations of operating conditions, bearings and oiling system, control mechanism, glands, couplings and protective devices against overspeeding.

Vibration caused by the flow of steam and by vibration of the entire rotor is the chief destructive element of all blading when operated under conditions of defective balance or alignment. Thickening the blade section near its base serves to reduce the amplitude of its vibration very considerably and to prevent concentration of deflection with its attendant crystallization at the point of attachment, where the ordinary blade is weakest. Blades may be lashed together to minimize the vibration and maintain uniform spacing. Blades up to 4 in. in height may have a single lashing near the top, blades from 4 in. to 12 in. may have two, and blades above 12 in. may have three.

To insure maintenance of clearances and alignment under all operating conditions, as reductions of steam pressure and total or partial loss of superheat or vacuum, is difficult but essential. The amount of expansion and contraction due to temperature changes is considerable in such large structures and usually occurs simultaneously with important stress changes caused by varying stage pressures; consequently a comparatively slight uneven temperature change or unbalanced stress will cause a distortion.

The introduction of high vacuum, accompanied by large diameters in the low-pressure stages, and enormous exhaust chambers necessitates a considerable amount of carefully devised ribbing and bracing, that the bearings supported in the exhaust chamber structures shall remain concentric with the stationary blade or nozzle-carrying elements under all conditions.

Practically every turbine element contains three bearings, two for supporting the rotor and one for maintaining longitudinal alignment. The oil-circulating system should be designed with special reference to positive circulation, effective cooling, straining and settling for separation of foreign matter or impurities, accessibility for thorough cleaning and longevity of the lubricating qualities of the oil. Under normal operating conditions the maximum temperature of the oil should not greatly exceed 140° to 150° F.

Since not only continuous service but also constant voltage and frequency have become a passion with public service companies, and a most commendable one too, the governing mechanism must be extremely sensitive, positive and quick to adjust itself to small or large changes in load and at the same time be rugged, reliable and unaffected by such variations as occur in ordinary wear and care. On account of the power required to operate the large valves, some form of relay mechanism is necessary. For this the regular turbine lubricating oil under suitable pressure has proved satisfactory.

Combination labyrinth and water glands constitute an excellent sealing arrangement to prevent leakage of steam or air where the rotor shaft passes through the casing. They require no adjustments for varying load conditions and do not depend on the operation of any automatic devices. There is no mechanical contact between stationary and rotating parts, and therefore no wear. They are extremely simple in design, require no special attention, and are as durable as any other part of the machine. The simple water gland is not adapted to operation at high pressures or at speeds much below normal, but a labyrinth enables establishing a vacuum before starting up and reduces the pressure on the water gland when the pressure against which the gland must seal is high.

Flexible-pin couplings have important advantages over the solid-claw type in that sufficient elasticity is provided to distribute the shocks produced by heavy short-circuits without injury to the coupling.

These observations may aid in establishing a deeper appreciation of the present and prospective future growth of the electric power industry, of the need therein of generating units of large capacities, and of the fact that such units have been built and are commercially successful and that there appears to be no engineering, manufacturing or economic hindrances to their general use.

The Interstate Light & Power Co. of Galena, Ill., a division of the Northern States Power Co., reports its largest week's electric energy output for the week ended Jan. 24. The total output during these seven days was 749,360 kw-hr., with a peak load of 8800 kw. Previous record was obtained at a time when the peak load was 9200 kw.

RESEARCH ORGANIZATION FOR THE ELECTRICAL INDUSTRY.

Mr. Fleming Outlines Its Scope, Buildings and Administration at Meetings of the English Institution of Electrical Engineers.

A. P. M. Fleming in a most timely paper which was considered by the English Institution of Electrical Engineers at meetings held in several British cities in January described the research organizations which industrial firms—particularly the large ones—required to establish in connection with their factories. He said that while all industries must provide for scientific research in their plans for future development, there was greater scope for research in the highly technical industry than there was in any other. He outlined the scope of a suitable research organization, the features which underlie its effective planning, its requirements with respect to staff, the design of the necessary buildings, the initial outlay and maintenance.

He provided data taken from modern laboratories in different parts of the industrial world in order to give sufficient guidance to those who desired to plan the essential features of a research organization for themselves. The laboratories, partly or wholly supported by industrial firms, were broadly classified according to the particular interests they were intended to serve, as follows:

(1) Industrial research laboratories self-contained and serving one particular works.

(2) Central industrial laboratories each forming the scientific focus of an industrial organization comprising several works, often in different industries, and linked up by control laboratories at the individual works. The function of the central laboratory is to conduct research bearing on the manufactures of all the works, and that of each control laboratory is to serve the immediate requirements of the works to which it is attached.

(3) Laboratories planned to serve a wide range of interests in various industries in connection with isolated problems, such as the Mellon Institute of Industrial Research, Pittsburgh, or ordinary commercial laboratories, such as that of A. D. Little & Co., Boston.

(4) Laboratories designed to serve the needs of one particular industry working on a co-operative basis such as the Laboratory of the National Canners' Association of the United States. The laboratories of the proposed research associations in Great Britain would fall into this class.

(5) State laboratories carrying out researches occasionally of an industrial character, but not necessarily for any particular firm, such as the National Physical Laboratory, the United States Bureau of Standards and various university laboratories.

The laboratories referred to in the paper comprised both routine and research work, their combination being the policy most likely to be adopted by manufacturers initiating research organizations. The functions of such a works research organization which involved arrangement of the department in a number of sections, were classified thus:

(1) Testing of raw material supplies and the establishment of a suitable technical basis for purchasing.

(2) Production of new materials or substitutes for those already in use, as for instance, high-speed tool-steels, improved magnetic sheet steel, etc.

(3) Investigation of difficulties arising in the manufacturing organization.

(4) Investigations necessary for controlling and maintaining at their proper level technical processes in manufacture.

(5) Development of new and improved processes and their establishment on a manufacturing scale on most economic lines.

(6) Development of methods for the treatment of factory waste and scrap for by-products.

(7) Investigation of phenomena required in the compilation of fundamental data for designing new apparatus.

(8) Development of new tools, appliances and methods of testing; improvement and standardization of those existing.

(9) Investigations of operating troubles and service for customers.

(10) Investigations for the information of financiers of the possibilities of new projects of a scientific character.

(11) Physiological and psychological investigations relating to vocational selection and for determining the most efficient means of employing human services.

(12) Research in pure science.

Mr. Fleming said that no hard and fast rule could be laid down as to the amount of money that should be expended on research. Every undertaking must be considered on its own merits and research expenditure based on the economic needs of the moment and the probable requirements of the future. In many cases it was the impoverished industry which stood in the greatest need of research. Similarly the small concern, though it might not be able to afford expensive research facilities, could make considerable use of those afforded by universities, national institutions, and private or commercial laboratories. Then, again, the wealthy firm or prosperous industry could maintain an unassailable position through improving by research its methods of production, this being ultimately the only effective method of securing monopoly.

It was an economic error to assume that the best method of increasing profits was, through trade combinations or other means of protection, to increase selling price. A much more logical method was to bring about greater difference between manufacturing cost and selling price by reducing the cost of manufacture, and it was in this connection that the possibilities of research were unlimited.

Apart from its value in assisting economic manufacture, the advertising value of research should not be overlooked. The knowledge that a manufacturing firm employed scientific methods established in the public mind a feeling of confidence in the firm's products. Similarly, this might be a by no means negligible factor in favorably influencing investors.

Mr. Fleming said it was to be hoped that firms undertaking research on a large scale would adopt a broad-minded policy in regard to the publication of a great deal of the results of their work. The tendency toward secrecy on the part of most British firms had been weakened to a considerable extent during war time, when many otherwise rival firms had been engaged upon similar kinds of new work, in which each firm could benefit by exchanging its experience with other firms engaged in the same production. This exchange of experience and information was of the greatest importance in keeping all sections of an industry up to date, and in this way an industry became much more potent in international competition.

In staffing a research organization the highest economy was secured by obtaining the very best brains.

Use of Higher Steam Pressures and Temperatures in Power Plants

Practical and Theoretical Considerations Involved—Their Effect Upon Turbine Efficiency, Design and Plant Layout—Abstract I. E. E. Paper

By J. H. SHAW

WITH the use of steam as a medium for carrying the heat contained in the coal from the boiler to the prime mover, it is unfortunate that, with the present knowledge of thermodynamics, the greater part of the heat in the coal is lost—a comparatively small portion up the chimney and the greater portion in the circulating water, via the condenser.

It is apparent that in order to increase the heat efficiency of a steam plant, whose characteristics are that a constant loss is inevitable whatever the temperature and pressure, it is necessary to increase the working range of temperature and pressure.

The upper limit is perhaps the temperature at

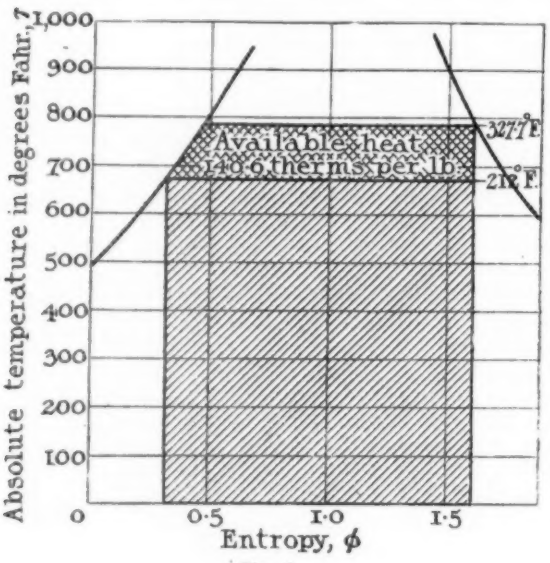


Fig. 1.

which metals rapidly lose their strength, and the erosive effect which the very hot steam will have on the blading of the turbine. The lower limit is generally decided by the locality of the power station. A works equipped with cooling towers cannot expect to obtain a lower bottom temperature than 75° F., and this only when the towers are amply proportioned and the ground space is not limited. A bottom temperature of 80° F. is more to be expected, which will give 28 in. vacuum or 2-in. absolute pressure. A power station located near a cold river or the sea, where the temperature of the water during the greater part of the year is approximately 55° F., can efficiently be equipped with condensing plant designed for 29.1 in. of vacuum, i. e., 0.9-in. absolute pressure. With cooling water at a temperature of 60° F. condensing plant for vacua between 28.5 and 28.8 in. can be installed.

A question that will appeal to all is "Will it pay?" A good case can be made out for a jump to 600-lb. pressure with a total temperature of 700 to 800° F., but this will involve a considerable amount of development charges being borne by the undertaking or undertakings which are the first to adopt such a pressure. On the other hand, it appears that practically all designs of existing apparatus can be so modified as to admit of pressure of 350 to 400 lb. per sq. in. It would, therefore, seems that to increase the working range of steam without the development of new designs a pressure of 350 lb. can safely be adopted.

When considering any results of tests on high-pressure or high-temperature steam generating plant, it is essential that the tests on the boiler side and the tests on the turbine side be studied separately; further, it must be remembered that any results obtained on an extra-high-pressure boiler can be obtained and, considering the boiler apart from the economizer, surpassed on a similar and similarly equipped low-pressure boiler.

By the aid of the temperature-entropy diagram the gain due to increasing the working pressure and temperature ranges of the substance can be shown with advantage. Assuming frictionless adiabatic expansion, Fig. 1 shows the amount of heat available in 1 lb. of dry saturated steam at a pressure of 100 lb. per sq. in. absolute (327.7° F.) expanding to 14.7 lb. per sq. in. absolute (212° F.) and is equivalent to 140.6 therms per lb. Figs. 2 and 3 represent the heats available per pound of superheated steam expanding from 365 lb. per sq. in. absolute (736.4° F.) to 1.5 in. (mercury) absolute pressure (91.6° F.) and 500 lb. per sq. in. absolute (736.4° F.) to 1.5 in. (mercury) absolute pressure (91.7° F.). The amounts of heat available are 470.2 therms and 485 therms per lb. of steam respectively.

The "Mollier" diagram, by means of which problems in adiabatic expansion can be graphically solved, has total heat as ordinates and entropy as abscissae. True isentropic or unresisted adiabatic expansion involves no change of entropy, and would be shown on the diagram by a straight vertical line. As an example, assuming that steam is to be expanded adiabatically from 200 lb. per sq. in. absolute saturated to 1 lb. per sq. in. absolute, the amount of heat in the steam before expansion can be read directly off the chart or obtained from tables in regard to steam, the value being 1205.4 therms. Following vertically down the chart until the pressure line 1 lb. per sq. in. is reached, it will be seen that the amount of heat still remaining in the steam is 866.70 therms, and that the steam is 76.5% dry. Subtracting the latter value from the former, $1205.4 - 866.7 = 338.7$ therms, gives the heat drop or the number of therms available between the ranges above specified. As another example with steam at 350 lb. absolute and superheated 250° F. and at a total temperature of 682.4° F., the initial heat is

1361.2 therms, the final heat amounting to 922.5 therms at 1 lb. per sq. in. absolute; the heat drop in this case is 438.5 therms. Comparing the two examples, it will be seen that there is a gain of 99.8 therms per lb. of steam or water, or 29.5% increase in available heat in steam at the higher temperature and pressure over the lower pressure, while only 12.9% extra heat units were

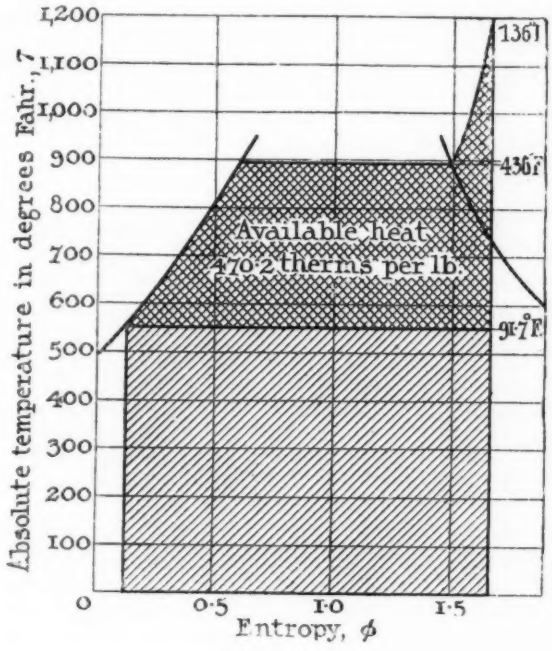


Fig. 2.

used in raising steam at the higher pressure over that required at the lower pressure.

The expansion that takes place in a steam turbine is not isentropic and is usually called adiabatic and resisted. Due to the friction, reheating takes place during the passage of the steam through the nozzles and blades, and the mixture gains in entropy. The amount of this gain can be calculated with considerable accuracy by turbine designers, and approximately by the user. Mr. Goudie, in his book on "Steam Turbines," has calculated a series of curves by which he arrives at the "reheat factor"; these curves are reproduced in Fig. 4 and can be used for multi-stage turbines and pressures between 150 and 200 lb. per sq. in. The curves are likely to be low for higher steam pressures.

For a comparison between the cost of running a power station at 200-lb. press (gauge) and at 350-lb. press, Schedule 1 has been prepared. It is proposed to consider a river-side station, where the water is suitable for surface condensing. It is proposed to install 20,000-kw. sets, and coal is assumed to be within a reasonable distance; the cost of the coal, with a net calorific value of 10,000 therms per lb., is for the purpose of the schedule assumed to be 10s. per ton at the works. The incombustible contents of the coal would amount to 20%. The average water temperature is taken to be 60° F., and the vacuum 28.5 in., with the barometer at 30 in. The overall efficiency of the boiler-house plant is assumed to be 77.5%, which should be obtained with modern boiler control.

Turbine makers are not all in accord as to the efficiency to be expected from turbines of the size under consideration when working on high pressures. A well-known firm states that between 200-lb. and 350-lb. pressure there will be a drop in ratio efficiency of 2½%; other manufacturers state that a turbine can be built with the same efficiency at 350 lb., as at 200-lb. pressure. There is no doubt that the increased density of the steam at the higher pressure will increase the internal losses in the turbine.

Martin, in his book entitled "Design and Construction of Steam Turbines," gives Dr. Lasche's formula for the power absorbed by rotating discs as:

$$\text{Power absorbed in kilowatts} = \frac{A}{5.5}\left(\frac{\text{r.p.m.}}{1000}\right)^3 \frac{dl}{V}.$$

d = diameter of wheels in inches;
l = average length of blades in inches;
V = specific volume of the steam;
A = a constant.

The constant is unity for a wheel carrying one row of moving blades, and 1.2 for wheels with two rows. The formula is said to be valid for wheel diameters from 35 in. up to 47 in., and for values of l ranging between ¾ in. and 2 in.

The author above quoted further states that "the resistance offered by a turbine wheel when at work is, however, quite different from its resistance when motored round; with a wheel at work and with complete admission there is no true windage due to the blades, whilst with partial admission the blades on the active arc are also free from windage."

In view of the above and the difference between the views of experts, it will be advisable to look ahead and anticipate that the efficiencies of turbines of the size under consideration will be improved in the near future. For the purpose of the calculations a turbine ratio efficiency of 80% is assumed, at both 200-lb. and 350-lb. pressure with the steam superheated 150° F. and a constant vacuum of 28.5 in. An alternator of 20,000 kw. capacity can no doubt be built to give an

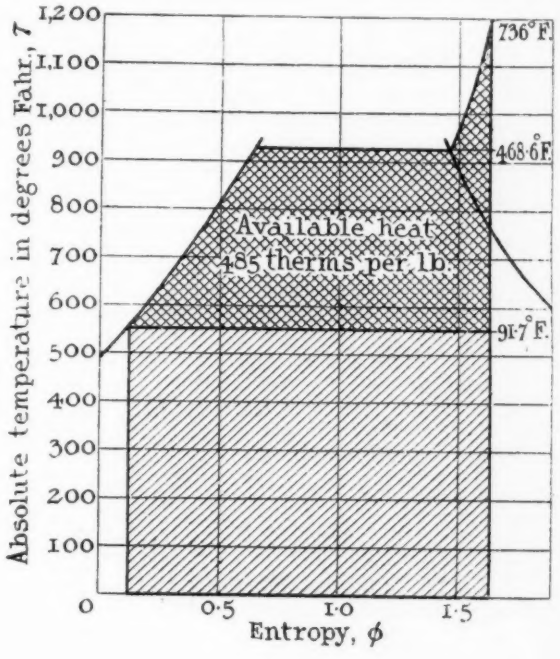


Fig. 3.

efficiency of 97% at unity power-factor, thus making the turbogenerator ratio efficiency $0.80 \times 0.97 = 77.6\%$. Assuming bearing and other friction losses to absorb 2%, the internal efficiency of the turbine will amount to 82%.

Schedule I shows the comparisons of coal, steam and heat consumptions for a 20,000-kw. machine running under the conditions mentioned, at 200-lb. and 350-lb. pressure by gauge at varying superheats; also at 500-lb. absolute and 268° F. superheat, at which pressure and superheat the total temperature will be 736.5° F., about the maximum temperature at present recommended for the materials now being used in turbine construction. Schedule I shows that the cost

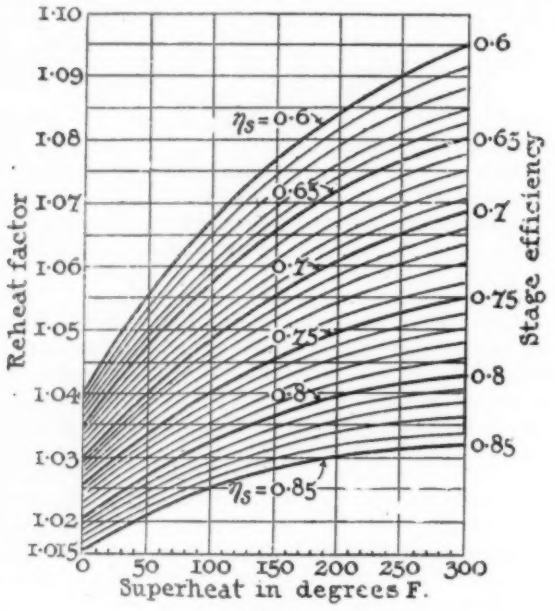


Fig. 4.

for coal when generating 175.2 million kw-hr. with a load-factor of 100% will be $313,800 at the higher pressure (superheat 250° F.), and $337,000 at the lower pressure with corresponding superheat. This is a saving of $23,200 per 175.2 million kw-hr., or 0.0133c per kw-hr. Unfortunately, a load-factor of 100% is impossible, and the conditions under which power stations are operated must be considered before even an approximate estimate of working costs can be arrived at.

An annual load-factor of 50% may mean full load for half the number of hours in a year, or anything between this and half load for the full number of hours in the year.

In order to avoid having to assume a curve of load and the necessity of calculating the consumptions at partial loads, a method of computation generally adopted for calculations of this nature, and one which is sufficiently accurate for this purpose, is to assume that the ratio of the station output to the total coal consumed is in accordance with Willans' law, i. e., a straight line.

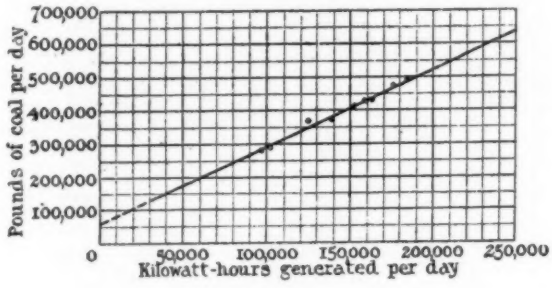


Fig. 5.

Fig. 5 is plotted from results obtained at one power station for a number of days during the year 1917, with the station conditions 180 lb. per sq. in. (gage); 100° F. superheat; 28 in. vacuum; 30 in. barometer. On this curve the weight of coal used is shown to be 60,000 lb. per day plus 2.32 lb. per unit generated. The quantity of coal per day, i. e., 60,000 lb., is the no-load consumption of the works, and will include the no-load consumption of one turbo-generator. In order to make the calculations as simple as possible, it is proposed to deduct the no-load consumption of one machine (5500 lb. of steam per hr.) from the works' no-load consumption, and to assume an evaporation of

SCHEDULE I—ABSOLUTE PRESSURE AT TURBINE EXHAUST, 1.5 IN. (Hg.) (91.7° F.), CONDENSATE TEMPERATURE, 85°F

Steam pressure at turbine	215 lb. per sq. in. (abs.)					365 lb. per sq. in. (abs.)						500 lb. per sq. in. (abs.)
Superheat of steam at turbine, ° F.	100°	150°	200°	250°	300°	50°	100°	150°	200°	250°	300°	268°
Total temperature of steam at turbine, ° F	487.9	537.9	587.9	637.9	687.9	486.4	536.4	586.4	636.4	686.4	736.4	736.4
Total heat in steam from 32° F., therms per lb.	1,265.0	1,293	1,319	1,345.5	1,371	1,249	1,278.5	1,307	1,335	1,363	1,389	1,382.7
Heat drop per lb. of steam, therms.	379.1	391	403.4	416.1	429.2	402.4	415.4	428.7	442.2	456	470.2	485
Ratio efficiency of turbogenerator	77.1%	77.6%	78.5%	79.0%	79.5%	75.5%	76.9%	77.6%	78.4%	78.9%	80%	80.2%
Internal efficiency of turbine	81.5%	82%	83%	83.4%	84.0%	79.8%	81.3%	82.0%	82.8%	83.4%	84.5%	84.6%
Steam consumption of turbine, lb per kw-hr.	11.7	11.25	10.8	10.4	10.0	11.3	10.7	10.28	9.86	9.5	9.15	8.89
Total steam consumption of turbine, lb. per hr.	234,000	225,000	216,000	208,000	200,000	226,000	214,000	205,600	197,200	190,000	183,000	177,800
Heat rejected to condenser from 32° F., therms per lb.	947	973	984	998	1,010	925	940	955	969	983	991	972.7
Ratio of circulating water to steam condensed	44	45	46	46.5	47.0	43	44	45	45.5	46	46	44
Circulating water, quantity, g.p.m.	1,029,600	1,012,500	993,600	967,200	940,000	971,800	941,600	925,200	897,200	874,000	840,000	785,000
Power for circulating pumps, b.hp.	163	160	157	153	149	154	149	146	143	138	133	124
Power for air and condensate extraction pumps, b.hp.	89	86	83	80	77	86	82	80	77	74	72	70
Power for boiler feed pumps, b hp.	104	100	96	92	89	166	157	151	145	140	135	177
Power for induced draft fans, b.hp.	222	220	220	216	212	218	212	207	203	200	195	186
Power for small auxiliary motors, b.hp.	57	56	55	54	51	61	58	57	55	54	54	56
Total power for auxiliaries, b.hp.	635	622	611	595	578	685	658	641	623	606	589	613
Total power for auxiliaries, kw.	530	515	510	495	485	565	540	530	515	500	485	510
Net output to busbars, kw.	19,470	19,485	19,490	19,505	19,515	19,435	19,460	19,470	19,485	19,500	19,515	19,490
Heat in steam from temperature of hotwell, therms per lb.	1.212	1.240	1.266	1.293	1.318	1.196	1.226	1.254	1.282	1.310	1.336	1.329.7
Steam consumption per effective kw-hr., lb.	12.01	11.55	11.09	10.67	10.25	11.62	11.00	10.55	10.12	9.74	9.39	9.124
Pounds of steam evaporated and superheated per lb. of coal, lb.	6.40	6.25	6.12	6.0	5.9	6.48	6.32	6.2	6.05	5.90	5.8	5.83
Coal consumption per effective kw-hr., lb.	1.88	1.85	1.82	1.78	1.74	1.80	1.74	1.70	1.68	1.65	1.62	1.565
Cost of coal at $2.40 per ton, generating 175.2 × 10^6 kw-hr. in dollars	356,000	351,000	346,000	336,600	329,500	340,800	331,600	323,900	317,500	313,900	311,500	293,200

6 lb. of water per lb. of coal, and to call the figure so obtained the works' standing loss.

$60{,}000 \times 6 \div 24 =$ no-load consumption of works in pounds of steam per hour $= 15{,}000$ lb. of steam per hour.

Deduct the no-load consumption of one machine $= 15{,}000 - 5500 = 9500$ lb. of steam,

and $9500/6 = 1583$ lb. of coal per hour.

To arrive at an estimated figure for the power stations under discussion, it is proposed to assume that the standing loss of the station designed for 200 lb. will be the same as for the power station referred to, i. e., 1583 lb. of coal per hour. It will be fair if the same basis is taken for the plant at 350 lb. pressure, not in the best condition, it will be advisable to add 5% to the figures obtained for the load consumption and 5% to the no-load loss of the turbine, thus making the consumptions and costs as below:

Maximum load of 20,000 kw. and 50% load-factor 87.6x10° units per annum.	200 lb. pressure, 250° superheat, 28.5 in vacuum.	350 lb. pressure, 250° superheat, 28.5 in. vacuum.
Work standing loss in tons of coal	6,200	6,700
No-load consumption of turbo-generators in tons of coal	15,100	15,314
Load consumption of turbo-generators in tons of coal	65,300	59,867
Total	86,600	81,881
Pound of coal per unit on station busbars	2.211	2.094
Total cost at $2.40 per ton	$213,000	$199,600
Cost of coal per unit	0.059c	0.056c

SCHEDULE II.

Steam pressure at turbine, lb. per sq. in. abs.	215	365	500
Superheat of steam at turbine, ° F.	300	251.6	219.4
Total temperature of steam at turbine, ° F.	688	688	688
Total heat of steam (from 32° F.), therms per lb.	1,371.2	1,363.2	1,356.0
Absolute pressure at turbine exhaust, inches (Hg.)	0.9	0.9	0.9
Heat drop per lb. of steam, therms	454.9	480.7	495.4
Ratio efficiency of turbine and alternator	79.5%	79%	78.6%
Internal efficiency of turbine	84.0%	83.4%	83 0%
Steam consumption of turbine, lb. per kw-hr.	9.46	9.00	8.77
Total steam consumption of turbine, lb. per hr.	187,600	180,000	175,400
Heat rejected to condenser (from 32° F.), therms per lb.	985	962	945
Ratio of circulating water to steam condensed	81	80	77
Circulating water quantity, g.p.h.	1,520,000	1,460,000	1,350,000
Power for circulating pumps, b.hp.	240	230	215
Power for air and condensate extraction pumps, b.hp.	92	90	88
Power for boiler feed pumps, b.hp.	84	133	180
Power for induced draught fans, b.hp.	197	187	182
Power for small auxiliary motors, b.hp.	62	64	66
Total power for auxiliaries, b.hp.	675	704	731
Total power for auxiliaries, kw.	560	580	605
Net kilowatt output to busbars	19,440	19,420	19,395
Heat in steam from temperature of hotwell, therms per lb.	1,331.2	1,323.2	1,316
Steam consumption per effective kw-hr., lb.	9.74	9.48	9.04
Pound of steam evaporated and superheated per lb. of coal	5 83	5.86	5.89
Coal consumption per effective kw-hr., lb.	1.67	1.62	1.536
Cost of coal at $2.40 per ton, generating 175.2×10^6 kw-hr.	$317,500	$308,300	$292,000

with 8% added to the works' standing loss representing roughly the higher temperature of the steam at the higher pressure. Standing losses must be approximately proportional to the top temperature, as this affects radiation, boiler exit losses, etc.

For a 20,000-kw. set the no-load consumption will be approximately 22,000 lb. steam, or 3666 lb. of coal per hour. These figures plotted in conjunction with the steam consumptions shown in Schedule I give the total steam consumption at any load as

A further schedule (No. II) has been prepared, showing comparative coal costs of riverside stations working at

200 lb. per sq. in. (gage), 300° F. superheat, and
350 lb. per sq. in. (gage), 250° F. superheat, and
485 lb. per sq. in. (gage), 220° F. superheat.

All the efficiencies and calorific values used in preparing Schedule I are used in preparing the schedule above mentioned, so that they are directly comparative.

SCHEDULE III.

	215 lb. per sq. in. abs. 250° F. superheat, 28 in. vacuum.	365 lb. per sq. in. abs. 250° F. superheat, 28 in. vacuum.
Total heat of steam (from 32° F.), therms per lb.	1,345.5	1,363
Heat drop per lb. of steam, therms	401.3	441.6
Ratio efficiency of turbo-alternator	79%	78.9%
Steam consumption per kw-hr. lb.	10.75	9.85
Heat rejected to condenser, therms per lb.	1,011.5	996
Ratio of circulating water to steam	63.5	62
Power for circulating pump, b.hp.	432	385
Total power required for auxiliaries, kw.	730	700
Pound of steam per kw-hr. on busbars	11.1	10.2
Pound of coal per kw-hr. on busbars	1.79	1.675
Cost of coal at $2.40 per ton per 175.2×10^6 kw-hr.	$340,800	$317,500

Circulating water at 80° F. discharged from condenser at 96° F. Efficiency of boiler house, 77.5%. Coal with a net calorific value of 10,000 therms per lb.

The head against which the circulating pumps have to work is taken to be 50 ft.

22,000 lb. + 9.54 lb. of steam per kw-hr.

for the plant operating at 200-lb. pressure, and

22,000 lb. + 8.6 lb. of steam per kw-hr.

and 3729 lb. + 1.45 lb. of coal per kw-hr. for the plant operating at 350-lb. pressure and 250% superheat.

In order to allow for changing over, for the period when two or more machines are temporarily running together at partial loads, for reduced efficiency in the boiler house due to adverse circumstances, and for the necessity of sometimes running the plant when it is

Schedule III shows the coal required, and power for auxiliaries, for a cooling-tower station working between 200 lb. per sq. in. gage, 250° F. superheat, and 350 lb. per sq. in. gage, 250° F. superheat exhausting against a back pressure of 1 lb. absolute pressure.

Schedule IV gives the relative steam consumptions with steam at a temperature of 688° F., 215 lb. per sq. in. gage, 265 lb. per sq. in. gage, and 315 lb. per sq. in. gage, exhausting against a back pressure of 1.5 in. of mercury or 28.5 in. vacuum.

With regard to the practical difficulties, it is but to be expected that before pressures of 500 or 600 lb. per sq. in. are adopted, a radical departure will have to be made in present boiler construction. All square boxes and headers will be eliminated, the drums and tubes will be smaller in diameter, and the design of the boiler made more elastic. The type of boiler will no doubt assume the appearance of a flash boiler, with practically no steam or water reserve, and fired by gas on the surface-combustion principle. For more moderate pressures, up to 350 lb. per sq. in., the existing type of boiler can be modified and successfully used.

With higher steam pressures the temperature of saturation is raised, and, due to this, greater care must be exercised in the quality of the water used for the boiler feed. A feed water that is perfectly satisfactory at 380° F. in a modern tubular boiler might be quite unsuitable for use in a flash boiler. The quantity of air, CO_2, and oxygen will have to be kept down to a minimum, and also the non-soluble salts which are generally in the water discharged from an ordinary lime-soda water softener. A natural development and one which is already taking place is to heat the feed water under atmospheric pressure by means of live or exhaust steam in order to drive off the entrapped and dissolved gases as much as possible. The accompanying table shows that it is necessary to raise the temperature of the water to 100° C. before the quantity of air in the water is appreciably reduced.

The source of water for use in high-pressure plants will have to be carefully traced, and the treatment of the water should be such that a minimum of unsoluble salts remains in it after treatment. The purer the water the greater affinity it has for air, CO_2, and oxygen, and every care should be taken that it is not exposed to the air between the condenser and the boiler. In order to avoid such exposure to the air it is suggested that the feed pump should be an extension of the condensate pump and the condensed water pumped direct into the feed line.

The natural development of the turbine for higher pressures appears to be in a line with Parsons two-cylinder machine, with a flexible claw-type coupling between the cylinders and a thrust bearing for each cylinder. For very large sets, above 50,000 kw., the cross-compound turbogenerator will no doubt be used, the high-pressure turbine being attached to a generator and the low-pressure turbine to another generator. Each set can then be run at its most suitable speed, with resulting high efficiency. This arrangement will no doubt lead to re-heating the steam after it leaves the high-pressure turbine and before entering the low-pressure machine.

The steam pipes to be used in a station where both high pressures and high temperatures are employed will have to be very carefully designed.

The question of expansion at higher temperatures will be of the utmost importance. For example, take the case of a steam pipe 100 ft. in length, and assume that the pipe had been erected at 60° F. It will be found that at a temperature of 388° F., equal to steam at 200-lb. gage saturated, the expansion is 2.59 in., while at 786.6° F. equal to steam at 600-lb. gage, and 300° F. superheat, the expansion is 5.75 in.

The expansion given can be readily taken care of if the designer can insure that the expansion would always take place lengthwise in the pipe range. Unfortunately, taking a boiler off a range will cause a considerable cross-strain to the main header, due to the connecting pipes cooling down and contracting.

SOLUBILITY OF GASES IN WATER.

Volume of gas [0° C. and 760 mm. (mercury)], d'ssolved by one volume of water at the temperature indicated if the partial pressure of the gas is 760 mm. (mercury).

Water temperature. C.	O*	H*	CO_2†	N†	Air*
30°	0.02608	0.01699	0.665	0 01380	0.01606
35°	0.02440	0.01666	0.592	0.01271	.....
40°	0.02306	0.01644	0.530	0.01182	0.01503
45°	0.02187	0.01624	0.479	0.01111	.....
50°	0.02090	0.01608	0.436	0.01061	0.01418
60°	0.01946	0.01600	0.339	0.01000	0.01297
70°	0.01833	0.01600	0	0	0.01216
80°	0.01761	0.01600	.....	.....	0.01156
90°	0.01723	0.01600	.....	.....	0.01126
100°	0.01700	0.01600	.....	.....	0.01105

*Winkler. †Bohr and Bock.

SCHEDULE IV.

Steam pressure at turbine, lb. per sq. in. ab	215	265	315
Total temperature of steam at turbine, ° F	688	688	688
Superheat at turbine, ° F	300	281.6	265.6
Total heat of steam (from 32° F.), therms per lb	1,371.3	1,368.6	1,365.9
Absolute pressure at turbine exhaust, inches (Hg.)	1.5	1.5	1.5
Heat drop per lb. of steam, therms	429.0	440.3	449.1
Ratio efficiency of turbine and generator	79.5%	79.1%	79.0%
Steam consumption of turbine, lb. per kw-hr	10.023	9.82	9.65
Total steam consumption of turbine, lb. per hr	200,460	196,400	193,000
Steam consumption per effective kw-hr., lb	10.3	10.10	9.94

SCHEDULE V.

Showing coal consumption, cost of coal and the amount of capital that can be expended to absorb the estimated saving per 87.6 million Kw-h.

Steam pressure	215 lb. per sq. in. (abs.)					365 lb. per sq. in. (abs.)						500 lb. per sq. in. (abs.).
Superheat, ° F	100	150	200	250	300	50	100	150	200	250	300	268
1. Coal consumption (lb.) per effective kw-hr. at 100% load-factor and no station losses	1.88	1.85	1.82	1.78	1.74	1.8	1.74	1.7	1.68	1.65	1.62	1.56
2. Coal consumption (lb.) per kw-hr. delivered to busbars at 50% load-factor	2.32	2.28	2.24	2.211	2.18	2.22	2.18	2.15	2.11	2.102	2.06	2.0
3. Annual cost ($) of coal at $2.40 per ton per 87.6 million kw-hrs. at 50% load factor	221,000	217,000	213,000	211,000	207,000	211,500	207,500	202,100	201,400	200,000	196,200	190,400
4. Estimated saving ($) per 87.6 million kw-hrs., taking 215 lbs. (abs.), 100° F. superheat as datum	.....	3,580	7,470	9,790	13,670	9,190	13,190	16,600	19,400	20,500	24,150	30,350
5. $ capital that can be expended for annual payments to absorb amount shown in line 4. Life of plant 15 years, and compound interest at the rate of 5%	.....	37,300	78,000	107,000	142,500	95,500	137,350	172,600	201,000	213,400	256,500	316,400

Outline of Factors Governing Economical Boiler Operation

Combustion, Loss Due to Excess Air, and Losses in Burning Coal—Accounted For and Unaccounted For Losses

By ROBERT JUNE

Mechanical Engineer.

This article is the second of a series on power plant management. These articles will discuss the various important phases of power plant management, factors that affect efficiency and economy. The power plant manager or superintendent reading this series will obtain a consecutive series of informative articles that may be educative for many, and in any case will serve to remind of the many factors in power plant operation requiring consideration.

THE war has been won, and some of the tension under which central stations have had to be operated has been relaxed—that is, theoretically. Actually, the amount of slack which has developed in the driving mechanism of industry to date, is negligible. The war has nearly doubled our economic resources, having added 7,000,000 trained workers, and countless new blast furnaces, steel plants, textile mills, agricultural machinery factories, plants for preparing food, shipyards, etc., to our industrial equipment. These workers and this equipment must necessarily be kept at work to supply a world-wide shortage of goods.

This means that the coal situation will continue acute. There is no prospect of our mining more than, or as much, as we can use during the current year. Coal must still be conserved and the place to conserve it is the boiler-room. In order to get at a thorough understanding of our problem, let us see what happens when we throw a shovel of coal into the boiler furnace.

Coal and air, the raw materials of combustion, are composed of a number of elements, which must be taken into consideration in arriving at an understanding of the cause of waste. Coal consists largely of carbon, hydrogen, oxygen, sulphur and earthly material or ash. Air is made up principally of oxygen, nitrogen and water vapor. In the furnace, these elements behave in the manner in Table 1.

If carbon and oxygen are brought together at a high temperature, 12 parts of carbon will unite with 32 parts of oxygen to form 44 parts of carbon dioxide, which means that 2⅔ lb. of oxygen are required to burn 1 lb. of carbon to carbon dioxide.

TABLE 1.

Name of element.	Chemical symbol.		What happens in the furnace.	Combines with oxygen to form.	Amount of oxygen required to burn.	Amount of air in lb required to burn 1 lb.	Heat developed in B. t. u. by complete burning of 1 lb.
Carbon	C		burns	CO_2	2.66	11.57	14,000
Hydrogen	H		burns	H_2O	8.0	34.80	62,000
Oxygen	O	doesn't	burn	....	....	....	.....
Nitrogen	N	doesn't	burn	....	....	....	.....
Sulphur	S		burns	SO_2	1.0	4.35	4,050

Our only source of oxygen is the air, which is composed of 23% of oxygen and 77% nitrogen by weight, so that to supply 1 lb. of oxygen to the coal it is necessary air as follows:

$$\frac{100}{23} = 4.35 \text{ lb. of air.}$$

which includes $\frac{77}{23} = 3.35$ lb. of nitrogen.

In order to burn completely 1 lb. of carbon, 2⅔ lb. of oxygen are required and 3⅔ lb. of carbon dioxide are formed.

As 3.35 lb. of nitrogen are introduced with every pound of oxygen, it follows that for 2⅔ lb. of oxygen, 8.92 lb. of nitrogen are used.

The result of burning 1 lb. of pure carbon in air is therefore

3.67 lb. of CO_2
8.92 lb. of N

12.59 lb. of flue gases.

As the ash in coal requires no air, and hydrogen is present in but minor quantities, the theoretical amount of air required to burn carbon is approximately that required for the complete combustion of coal—that is 12 lb. of air in a perfect furnace.

In the actual furnace it is necessary to supply more than the theoretical amount of oxygen. The percentage of excess air depends upon the size and character of the coal, kind of furnace and grates, depth of fuel bed, method of firing, draft and other variables. But it may be set down as an axiom that where much over

TABLE II.

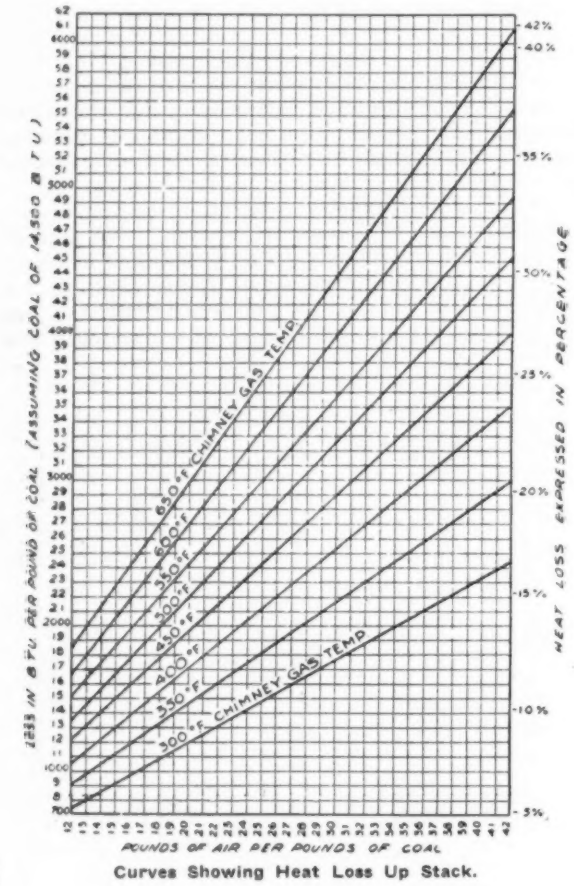
Percentage excess air.	Theoretical temperature of combustion, ° F.	Loss of temperature due to excess of air, ° F.	Loss expressed in terms of percentage.	Relative boiler capacity, assuming 40% excess air as normal attainable practice or 1005.
0	5,132	0	0.0	....
10	4,710	422	8.2	....
20	4,352	780	15.2	....
30	4,044	1,088	21.2	....
40	3,777	1,355	26.4	100.0
50	3,543	1,589	31.0	93.5
60	3,336	1,796	35.0	88.2
70	3,153	1,979	38.6	83.0
80	2,988	2,144	41.4	78.5
90	2,840	2,292	46.7	74.5
100	2,705	2,927	47.3	70
125	2,419	2,713	52.9	63
150	2,188	2,944	57.4	56.6
175	1,997	3,135	61.1	51.5
200	1,837	3,295	64.2	47.0

40% excess air is used for combustion, there is something radically wrong.

The cooling effects of various percentages of excess air are indicated in Table II.

So far as concerns the efficiency of steam production, it would make no difference at all what the temperature of the fire was or whether 12 or 120 lb. of air were used for each pound of coal, so long as the fuel was completely burned and the boiler surface large enough to absorb all the heat in the gases. With an ideally perfect boiler that could absorb heat from gases until they were cooled down to air temperatures, it would be immaterial how much air had been used to burn the coal, or what the temperature of the gases was, because all their heat would be absorbed. Unfortunately, it is not only impossible but impracticable to build boilers of this kind. Heat cannot be absorbed effectively by a boiler from flue gases which are much cooler than 500 to 600° F. Furthermore, this temperature is usually required to produce the necessary draft, and unless the quantity of gas is kept down to a small volume the draft will be impaired because of the friction loss due to the resistance of fuel, boiler and chimney.

With the actual boiler then, it makes a great deal of difference whether 12 or 120 lb. of air are used to burn 1 lb. of coal. In one case 13 lb. of hot gas are going up the chimney, and in the other case 121 lb. These hot gases are the chief "waste product" of the boiler plant or steam factory and they constitute the largest item in the total waste of 40% occurring in the average plant. Evidently the loss due to heat carried away by this waste product, is reduced by taking the minimum amount of air. But just as the factory manager must keep tab on his waste in order to eliminate it, so must the engineer measure the amount of his waste product in order to take steps toward its reduction. The amount of chimney gases per pound of coal is obtained by measuring CO_2 or carbon dioxide; the heat in each pound of these gases is measured by their temperature. All of the important causes of loss in a boiler plant will be considered briefly and their extent pointed out, and, if possible, how much each loss may be reduced.



Curves Showing Heat Loss Up Stack.

Heat Losses in Burning Coal.

A boiler, in order to utilize the heat of combustion of the fuel must be free from radiation and leakage losses, the fuel must be completely oxidized, and the products of combustion must be discharged at atmospheric temperatures. Commercially such conditions are unobtainable, hence complete utilization of the heat generated is impossible. A boiler which utilizes 83% of the heat value of the fuel is exceptional and an average figure for very good practice is not far from 77%. The various losses including the heat utilized by the boiler, constitute the commercial "heat balance." The losses considered are:

1. Loss in the dry chimney gases.
2. Loss due to incomplete combustion.
3. Loss of fuel through the grate.
4. Superheating the hygroscopic moisture in the air.
5. Moisture in the fuel.
6. Loss due to the presence of hydrogen in the fuel.
7. Unburned fuel carried beyond the combustion chamber in the form of soot or smoke.
8. Radiation and minor losses.

Some of these losses are preventable. Others are inherent, and cannot be avoided.

Loss in the Dry Chimney Gases.

This is usually the greatest of all losses. The type and proportions of the boiler and setting, and the driving rate, are factors which govern it. The amount of heat carried away, under varying conditions, is shown graphically in Fig. 1.

It will be noted that the extent of air dilution and the temperatures at which the gases leave the boiler, indicate the magnitude of the loss. Flue temperatures less than 450° F., are seldom experienced except in connection with economizers, and as the air dilution is ordinarily well over 40%, the loss from this cause may range from 8 to 40% of the total heat generated.

The amount of this loss can be cut down by reducing the weight of the heat-bearing gases, by only admitting to the furnaces the minimum practical amount of air, by preventing leaks in the furnace setting, and by reducing the temperature of the gases, by keeping the fire surface of the boiler clean through the use of mechanical soot blowers.

CO_2 analysis apparatus is invaluable in determining this loss and furnishing a basis on which to lessen it.

Loss Due to Incomplete Incombustion.

If the volatile gases are not completely oxidized, as when the air supply is insufficient or the mixture of air and gases is not quite thorough, some of the carbon may escape as carbon monoxide. Some of the hydrocarbon may also pass through the furnace without being burned. The presence of even a small amount of carbon monoxide (CO) in the flue gas is indicative of appreciable loss, as will be seen from Fig. II.

If the furnace is properly designed, these losses may be reduced to an almost negligible quantity by careful operation. With a good and even fire bed, having a thickness suited to the effective draft, only traces of CO, hydrogen, etc., should be found. If the

losses exceed 2%, there is something wrong and pains should be taken to find out whether the trouble is due to poor design or careless firing, so that it can be eliminated.

Loss of Fuel Through Grate.

In average practice the unconsumed carbon found in the ash pit ranges from 15 to 50% of the total weight of dry refuse depending upon the size and quality of coal, type of grate and rate of driving. This loss of fuel runs from 1.5 to 10% or more, of the total heating value. Although various attempts have been made to assign an average percentage to this loss, they have been without result or value. Numerous tests of recent mechanical stoker installations have indicated losses ranging from 1.5 to 5% of the heat value of the coal at normal driving rates.

This loss can and should be reduced by proportioning the grate openings to suit the size of the coal burned, careful handling of the fire, and, when practicable, the substitution of free-burning for caking coals.

Loss Due to Superheating Moisture in Air.

This loss is, in the main, a minor one, ranging from 2 to 4%, except on hot, humid days or at plants located at points of excessive rainfall or near the sea coast. As it cannot be controlled, except as excess of air is controlled, it is not discussed further.

Loss Due to Moisture in Fuel.

If present in large quantities, moisture in the fuel represents an appreciable loss in economy, since the heat necessary to evaporate it into superheated steam at chimney temperature is lost. Firemen occasionally wet coal to assist coking or reduce dust, but moisture thus added necessarily reduces the theoretical furnace efficiency.

Under certain conditions, wet coal may give a higher evaporation than dry coal, that is, through a purely mechanical action, the moisture may assist in packing the coal, thus reducing the loss through the grate, or in cases of thin fires, reduce air excess. The occasions when the application of the hose to the coal pile is warranted are of limited frequency, however, and firemen should be under strict instructions never to apply water without the specific consent of the boiler-room foreman.

It follows, from what has been said, that coal known to be high in moisture should not be purchased without adjustment of prices to compensate for lowered efficiency.

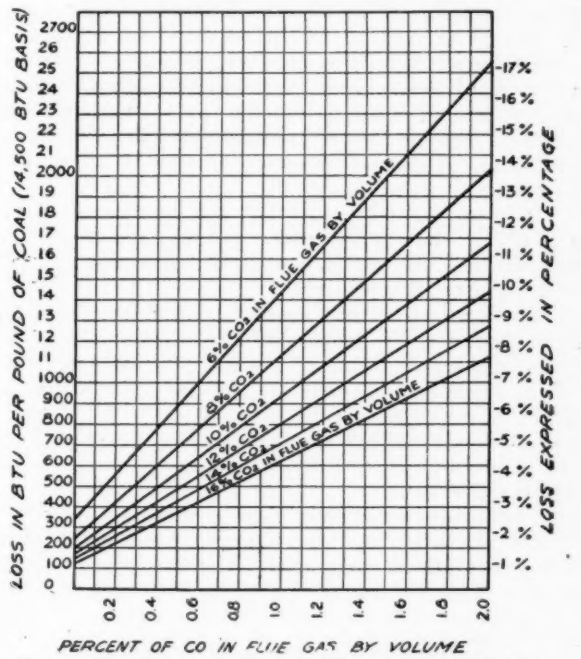
Loss Due to Presence of Hydrogen in the Fuel.

That part of the hydrogen in fuel, which is in a free state, burns to water, and in so doing, liberates 62,000 B.t.u. per pound. Unfortunately, all of this heat does not become available for producing steam, since the water formed by combustion is discharged by the flue gases as superheated steam, at chimney temperature. This loss is inherent. With anthracite, it approximates 2.5% of the heating value, and with bituminous, 4.5%.

Loss Due to Visible Smoke.

The loss due to smoke is very visible, but it cannot be weighed or measured and is generally over-estimated. Smoke consists of carbon in a flocculent state, and ash mixed with the products of combustion.

The losses due to visible smoke seldom exceed 1%. It must be remembered in considering this loss that a smoky chimney does not necessarily indicate an inefficient furnace. Paradoxical as it seems, a smoky chimney may be much more efficient than one which


LOSS IN BTU PER POUND OF COAL (14,500 BTU BASIS)
LOSS EXPRESSED IN PERCENTAGE
6% CO2 IN FLUE GAS BY VOLUME
8% CO2
10% CO2
12% CO2
14% CO2
16% CO2 IN FLUE GAS BY VOLUME
PERCENT OF CO IN FLUE GAS BY VOLUME

Curves Showing Loss Due to Incomplete Combustion.

is smokeless; that is, a furnace operating with minimum air supply may cause dense clouds of smoke and still give a higher evaporation than one made smokeless by a large excess of air. There will, of course, be some loss due to carbon monoxide, unburned hydrocarbons, and combustible in soot in the former case, but this may be more than offset by the excessive losses caused by the heat carried away in the chimney gases in the latter. The amount of combustible in the ous parts of the setting, seldom exceeds one per cent soot and cinders deposited upon the tubes and in vari- of the calorific value of the fuel.

Radiation and Unaccounted-for Losses.

These losses are determined by simple arithmetic, being the difference between the sum of the heat rep-

Table III.

Per Cent of Calorific Value of Coal as Fired.

Heat absorbed and losses itemized.	Highest attainable efficiency.	Excellent Practice	Good Practice	Average Practice	Poor Practice
Heat absorbed by boiler...	89.86	80.0	75.0	65.0	60.0
Loss due to free moisture on coal	0.50	0.5	0.6	0.6	0.7
Loss due to hydrogen in coal (evaporation of H_2O)	4.20	4.2	4.3	4.3	4.4
Loss due to heat in dry flue gases	5.33	10.0	13.0	17.5	20.0
Loss due to carbon monoxide	0.00	0.2	0.3	0.5	1.0
Loss due to combustible in ash and refuse	0.00	1.5	2.4	4.5	5.5
Loss due to heating moisture in air	0.11	0.2	0.2	0.3	0.4
Loss due to unconsumed hydrogen, hydrocarbon, radiation and unaccounted-for	0.00	3.4	4.2	7.3	8.0
Calorific value of coal.....	100%	100%	100%	100%	100%

resented in the steam and the losses previously mentioned, subtracted from the 100% total heating value in the fuel. Consequently, unless careful attention is given to accuracy of determination of other losses, the figures arrived at for this loss will be in error.

Radiation losses should not exceed 2%, and as a matter of fact, do not, with well-designed, well insulated boiler furnaces. On the contrary, with poorly installed settings, where insulation is not properly attended to, radiation losses may amount to as much as 6 to 8%.

It is undoubtedly true that this loss equals a full 4 to 6% in the average plant and that it could be cut squarely in two with a comparatively small expenditure for insulating material.

The sum of all the losses and the heat absorbed by the boiler, when distributed in a table or on a graph, gives us the heat balance. As the operating engineer, when searching out means for the elimination of losses, is concerned with "coal as fired," any general representative heat balance, such as is shown in Table III, is of value for purposes of relative, but not absolute comparison.

The losses which have been considered, cover continuous operation of the boiler at normal or high rating. In addition there are other important sources of loss in operation, such as standby losses, blow-off losses, losses due to leaky traps, valves, etc. These will all be discussed later. In the next article will be taken up in greater detail the determination and control of operating losses through the use of instruments.

(To be continued.)

BRITISH POLICY ON ELECTRIC POWER SUPPLY.

Important Report by Institution of Electrical Engineers—Industry United in Recommendations—Permanent Government Electrical Commission.

The most representative body of men that has ever considered the question of British electric power supply has just placed before the president of the Board of Trade a carefully prepared statement on the whole subject of national electricity supply in which it embodied recommendations leading to drastic revisions of the conditions under which the industry has hitherto been carried on in the United Kingdom.

The body referred to was set up by the Institution of Electrical Engineers in June last and it was composed of representatives of all the great electrical organizations excepting those acting for municipal electrical systems; the latter were invited to co-operate in the study, but they were preparing separate reports for direct submission to the Board of Trade. The reason why the Institution of Electrical Engineers set up the committee is found in the conviction that as it was the body including and representing those engaged in all sections of the electrical industry it was its duty to obtain and collate the opinions of all sections on the fundamental issues involved in new legislation. It was recognized that the future course of development in electric supply for industrial and domestic purposes, in electric traction, in electrical manufacturing, and in many other branches of electrical business depended upon the character of such legislation, and the vital importance of a cheap and abundant supply of electricity to the engineering and other industries influenced the Institution not only to appoint the committee but to include thereon representatives of the most important consumers of electric power.

The various sectional interests prepared separate reports, and as some of these were less detailed than others, a combined opinion on all the matters dealt with by the two Board of Trade committees was not possible, but there was no material difference of opinion displayed on any point of primary importance. Indeed, on the main issues relating to present electrical legislation the various sections showed an impressive unanimity among the large groups of electric supply undertakings (central stations), electrical manufacturers, consulting engineers and important users of power for industrial purposes.

The following recommendations and views set forth in the present Institution of Electrical Engineers' report may therefore be regarded as the united convictions of many sections of the industry:

Summary of the Report.

(a) The restrictive conditions embodied in the Electric Lighting Acts, the Tramways Act, the Light Railways Act, and the various acts relating to electric power supply have had a most detrimental effect on electrical progress in Great Britain. This legislation has led to the multiplication of small arbitrary, and uneconomical areas of electricity supply and systems of electric traction; it has discouraged the investment of capital in electrical undertakings by imposing limited tenure with unattractive terms of expropriation, and various other onerous conditions; it has placed obstacles in the way of grouping undertakings into comprehensive systems of supply and transport; it has, generally, prevented British electrical engineers and manufacturers from realizing in their own country the highest achievements of which their technical skill and productive capacity were capable, and it has, in consequence, put them under a serious handicap in the competition for export business against countries in which the conditions have been more favorable for successful commercial demonstration.

(b) The evil effect of past legislation, emphasized so strongly by both the official reports, necessitates drastic reform of the enactments referred to, both in the spirit and the letter, if the industry is to fulfill its function of providing cheap and abundant electricity for industrial, agricultural and domestic purposes, and for the development of electric traction on railways, light railways and roads.

(c) In addition to releasing electrical enterprises from the existing disabilities the chief necessities of the situation are: (1) The treatment of the problem of electrical generation and distribution on broad lines, and (2) the provision of simple forms of procedure in obtaining powers for electrical utilities of all kinds.

(d) In order to secure these and other essentials of ordered progress, the proposed appointment of a Board of Electricity Commissioners is welcomed, subject to the provisions expressed below.

(e) The committee is strongly convinced that, owing to the complexity of the technical, administrative and financial problems involved in a comprehensive scheme of electric supply reform, it will be found altogether impracticable to deal directly with the task of reconstruction by means of general legislation covering all the points at issue. The committee accordingly urges that immediate action should be confined to the creation of the Board of Electricity Commissioners, who should have powers and functions as outlined in the following paragraphs. There should

be a gradual development in the establishing of the administrative machinery as the necessity is felt, otherwise the industry may be hampered in the future by excessive organization to the same extent as it has been in the past by the conditions which have been referred to.

(f) This board should be a tribunal of skilled men, free from political influence, charged generally with the duties of (1) examining all proposals for the extension and consolidation of existing electrical enterprises; (2) recommending to the Board of Trade and to Parliament, for authorization, schemes which are on the soundest financial and engineering lines, and (3) advising the Government on legislative matters for the encouragement of the electrical industry.

(g) The functions of the board should be exclusively judicial and advisory. Strenuous objection is urged against the granting to the board of administrative powers over electrical undertakings, and also of authority to appoint district boards in the event of such bodies being constituted. In this respect the powers of the commissioners should be limited to examining schemes brought before them for dealing with the various districts.

(h) The preparation of such schemes, whether company, municipal, or joint, should be left as a matter of free and natural development to the initiative of undertakers who would formulate such schemes (it may be rival schemes), and put them forward for the consideration of the commissioners, who would report to Parliament upon any bills intended to carry them into effect. Opponents would be entitled to be heard against such bills in the usual way.

(i) The board may be empowered to deal with the electrical rules and regulations administered by the Board of Trade and the Home Office, and it may also act as arbitrator and as a court of record for the electrical industry.

(j) The Railway and Canal Commission is suggested as a general model for the constitution and powers of the board.

(k) The number of commissioners on the board should be five, and in all cases the appointments should be permanent, or for long periods, and should be on such conditions as will attract men of the highest ability, knowledge and independence. One member should be skilled in legal affairs and in sifting evidence, one in finance, one in the problems of electrical manufacture, and the others with experience in engineering and the management of electrical undertakings.

(l) While in the main the work of the board will consist of formulating the principles of procedure in the course of electrical progress, and of recommending the legislative amendments and the specific schemes which are in agreement with these principles, it may be necessary in some cases for the board to propose the enforcement, by Parliamentary authority of arrangements, for interconnection or amalgamation of supply undertakings.

NORTHERN STATES POWER PLANT GIVEN HIGHEST EFFICIENCY RATING.

The Riverside steam turbine station of Northern States Power Co., located at Minneapolis, Minn., received a rating of 100% in an efficiency survey conducted in 1918, by the Bureau of Conservation of United States Fuel Administration. This plant is operated by the Minneapolis General Electric Co.

APPLYING EXPERIENCE OF CRIPPLED SOLDIER TO ADVANTAGE OF ELECTRICAL BUSINESS.

How the Crippled Workman May Be Rehabilitated to Self-Support and Use in the Community Instead of a Pensioner or Charity Subject—Advantages to All Concerned.

By Douglas C. McMurtrie,
Director, Red Cross Institute for Crippled and Disabled Men.

In the past our method of dealing with men permanently disabled in the course of employment has been to pay the worker a pension in the form of compensation, and forget him and his injury. But the cost of disability in the electrical industry has not been alone in premiums paid for casualty insurance. There has been the cost involved in training experience, and adaptation of a skilled worker who does not return to his job, and the fitting of a newcomer to take his place.

There are three means of reducing and approaching the complete elimination of the cost of disability: first, accident prevention; second, through medical attention to minimize the disability resulting from the injury; third, salvage of the remaining abilities of the worker through rehabilitation for self-support. The first of these has already received wide attention from employers and has wisely been encouraged in a financial way by casualty insurance companies and state funds. The values of the two latter have, however, not as yet been properly appreciated. Their energetic application would effect a tremendous saving to industry.

Best Medical and Surgical Care Needed.

Many injuries from which men would completely recover in a short time under adequate and high-grade medical attention are treated for an insufficient time, or by incompetent physicians and, instead of a prompt return to work, the case at best drags along over an extended period and at worst becomes chronic or develops into permanent disability. Some states require the insurance carrier to provide but two weeks of compulsory free medical attention to the injured man. For the insurance company to take advantage of this limitation is the most short-sighted policy possible, because for every dollar saved in physicians' or hospital fees, the insurance carrier pays out later ten dollars in compensation. And what the insurance company pays is actually paid by the insuring employers in their regular premiums.

Unlimited medical attention of the highest grade should be an axiom of casualty practice. It should be insisted upon by employer and workman alike. The best outcome of any injury is to have the employe return to his job as a well man in the shortest possible time. It is well to develop a science of dealing with cripples, but the ideal is to have fewer and fewer cripples with which to deal.

The third method of attack on the cost of disability is rehabilitation for self-support—the re-education of an injured man for an occupation which he can follow, or a process which he can perform, in spite of his handicap. The science of rehabilitation is new, and the experience in it has practically all been gained in the effort to make sound and just provision for the disabled soldier or sailor. Every country among the recent belligerents is today operating a comprehensive

system of re-education for disabled soldiers, and is placing upon that system more dependence than upon the pension system.

Paying a man a small monthly or weekly stipend on which he is expected to live in idleness is not a very constructive method. With the breakdown of confidence in the pension system it was realized that the only real compensation for disablement was restoration of capacity for self-suport. It was further realized that very few jobs require all the physical faculties and that in the present-day variety of industrial processes it is possible to find a job in which a man with a given type of disability can function 100% efficient. Some jobs are standing work, some seated, others require walking about, some jobs at a bench working on small articles require but little strength, others involve great physical exertion. Still others do not require the sense of hearing, in others the sense of sight is not essential. Finding the future work of the disabled man, therefore, requires expert and painstaking choice, but a successful selection is possible even for the seriously handicapped. The first aim is to place the man back in a different job in his own trade or in a trade closely related. In such a job his past experience will stand him in good stead. Failing this, he can be retrained for a different line.

The process of retraining the disabled is known as re-education, and can best be provided in a special school for crippled men. The first school of this kind in the United States is the Red Cross Institute for Crippled and Disabled Men, established in New York City through the generosity of Jeremiah Milbank. At this school, open to disabled civilians and soldiers alike, six trades are already being taught: artificial-limb making, motion-picture operating, oxy-acetylene welding, printing, jewelry work, and mechanical drafting. More will be added as the demand develops. Graduates are already giving satisfaction in the jobs to which they have been graduated, so the enterprise has passed the experimental stage. And in the results attained with disabled soldiers abroad there is overwhelming evidence of the logic and practicability of rehabilitation.

The cost of rehabilitation is being met by the United States Government and by the governments of some of our allies. It will be admitted, without argument, as desirable that the advantages of re-education be made available to disabled civilians as well, but will not the cost be prohibitive? The fact is that rehabilitation effects a reduction rather than an increase in the cost of disability to industry or to the community as a whole.

Example of the Value of Re-education.

A typical case will illustrate how the saving is effected. A worker in Massachusetts was injured by a fall while working inside a submarine and his hand became permanently crippled. In due course his compensation rate was determined and he was referred to the insurance carrier to be paid $10 a week for a long period, with a maximum total payment of $4000. Since the disability was manifestly permanent, the insurance company wrote the case off its books as a $4000 loss and transferred that amount to reserve to cover the weekly payments. After the compensation had been paid for nearly a year, a new official of the insurance company began looking over the list of men to whom the company was paying compensation. His attention was directed to the man in question and the latter was requested to call at the office of the company. The case was like many thousands of others susceptible of rehabilitation for self-support, so the insurance company official put a proposition to the man in very frank terms. "I believe that you can be trained to earn a good living. I want you to understand very clearly, however, that this proposal is to the financial advantage of the company, but I also believe it is to your advantage as well. A total income of ten dollars a week is not very attractive to you and you would probably rather return to work at a good wage than remain idle. If you will consent, the company will send you to a school of re-education and see if we cannot get you back on your feet in good shape."

The injured man consented to the proposal and the company sent him to the Red Cross Institute in New York. They began to pay him not $10 a week as required by law, but $40 a week, $20 to him in New York and $20 to his wife at home. The company also paid liberally his traveling expenses in both directions. In the period of eight weeks he was re-educated in oxy-acetylene cutting and welding and returned home. He is now making not only a satisfactory wage but twice as much as he had ever earned before the accident took place.

In the whole transaction every party at interest was benefited. The man was advantaged in that his general living standard was distinctly raised, and the necessity of working for his living could not be considered as a hardship. The company paid less than $500 for his rehabilitation and this expense in conjunction with the $500 already paid in weekly compensation during the first year of idleness made a total for the case of $1000. The company was thus enabled to charge $3000 of profit to the account of profit and loss. The community was infinitely the gainer in that the man, formerly an unproductive consumer, became a useful producer instead. The community further gained in the elimination of the disabled man from the category of a prospective dependent, because while compensation might have taken care of him in a very insufficient way during the period of idleness, there would have come a time when compensation ceased and then he would have been in a desperate economic status indeed—confirmed in habits of idleness, untrained for skilled work, and without any source of support.

A more intelligent handling of disability by insurance carriers will, therefore, reduce their expense, and will thus cut the cost of casualty protection to the employer. There is needed also, however, some revision of compensation laws so that there may be definite encouragement to insurance carriers to offer opportunity of rehabilitation and definite encouragement to the disabled men to take advantage of it. Practically every compensation case that has ever come to the Red Cross Institute has come on the day his compensation expired. For one year, for two years, or for four years the man has existed in idleness, drawing compensation, and cultivating habits of indolence. When his support was cut off, he then became interested in rehabilitation. Present compensation legislation tends to encourage the man to remain idle because his payments are reduced by any improvement in earning capacity. A revision of this practice will make for more constructive provision.

In short, the first effort should be to prevent injury, the second to minimize its permanent effects, the third—when disability has ensued—to offset its economic consequences. The execution of this complete program is not only sound humanitarian practice—it is good business as well.

Editorial Comment

Square Deal as Preventive of Strikes of Public Service Employes

WAVES of industrial unrest are spreading over many countries and causing much needless suffering as well as prolonging the period of readjustment from war to peace conditions. By some these waves of discontent are attributed to the insidious spread of bolshevist propaganda, by others to desperate efforts to maintain war-time inflated wage scales or abnormal working conditions. At any rate, serious labor disturbances have spread even to our own cities of Seattle, Tacoma and Butte; in the British Isles they involved not only industrial workers but also practically all the operatives of the electric underground tube railways and several other of the urban transportation systems of London, thus leaving millions in the big city to walk many weary miles of slushy streets. If news dispatches are dependable, the issues involved in the general strikes in London, Glasgow and elsewhere, were seemingly trivial compared with the great inconvenience, suffering and actual loss resulting from the tie-up and this raises again the question of the propriety of the employes of public utility systems quitting in a body and leaving the public without very essential service.

This question has been debated in this country on numerous occasions when similar strikes have tied up street railway or other forms of public utility service. Arbitration has frequently been proposed as the preventive of such strikes and in many instances it has saved the day. In too many cases, however, obstinate stubbornness on one or both sides of the controversy has prevented a fair application of arbitration until it was too late to prevent the tie-up. On several occasions the right of the public to step in as a much interested third party and insist on a settlement has been pointed out in these columns. The proceedings of the past year and possible similar controversies to those that have been agitating the British and some of our own cities suggest further careful consideration of the subject.

In the first place it must be recognized that the public has a paramount right to intercede in such a dispute. This is because public utility service is of an entirely different type from the ordinary commercial or industrial business. It does not deal in commodities that can be manufactured, stored and sold at convenience, but is primarily a service rendered at the instant that the public needs it. This is especially true of telephone, passenger transportation, and electric light and power service. Delay represents much inconvenience and loss, while entire cessation of the service may mean not only these but also great danger to the entire community. Moreover, any changes effected directly or indirectly in the wage and salary expenses of the utility as the result of any labor dispute have a direct bearing on the income which the utility must have to meet these expenses. While this is true in any business, the conditions are radically different in a utility under the modern system of public service regulation. The utility cannot suddenly impose a rate increase to meet a wage increase. Consent of the regulatory commission or sometimes of the local authorities is necessary before this may be done.

All this shows the great need of going slowly before involving public utility employes in a strike. Even where a strike has been prevented by arbitration the method followed has not always been the best or most equitable. This was especially true of the arbitration settlements effected by the War Labor Board in the case of numerous street-railway wage disputes last summer. The criticism we make is not against the award, which was meritorious in view of the increased costs of living, but against the lack of power of the board to see that the railway companies were provided with increased income—that is, higher fares, to meet the additional operating expenses. As we have stated before, the logical body to take up all these questions is the utility regulating commission which can simultaneously investigate the financial ability of the utility to meet increased obligations and authorize higher rates where greater income is evidently needed. The sudden imposition of greatly increased operating costs by an outside body has so embarrassed many electric railway companies as to throw them virtually into bankruptcy.

The substance of the matter is that strikes by utility employes are a great detriment, if not menace, to the community. They should be prevented at all hazards. The most logical preventive is at the source. Every effort should be made to give the employes decent working conditions and remuneration. If disputes arise they should be freely discussed between management and the men, keeping in view that the public is deeply interested. Should a settlement be not effected here the matter should be brought before the regulatory commission, whose power should be broadened to include consideration of such matters. Above all, it should be remembered that it is necessary to give a square deal to all concerned—the employes, the utility stockholders and the public. A special or a general strike involving public utility employes certainly is *not* the way to give a square deal to the public. A preventive must be found. Fair play and justice to all should develop the solution.

Steam-Turbine Reliability

RELIABILITY, which assumes safety, is undoubtedly the first and foremost attribute demanded of the steam turbine for central-station service. Economy of operation, which embraces low water rate and low fuel maintenance charges, while vitally important, is a secondary requirement. There are two different aspects in considering steam-turbine reliability or safety, for the two are synonymous. The first concerns the designer of the turbine; the second those that operate it. And to a large extent the designer is very seriously concerned with the manner in which the turbine he designs is operated, for a design of a unit to be reliable must take into cognizance external as well as internal factors, theoretic and practical, within and beyond the control of the designer who is called upon to allow for them.

Elsewhere in this issue J. F. Johnson discusses the reliability of large turbogenerators, giving the etiology of nine units of from 35,000 to 70,000 kw., covering a period of more than three years. Some of the phases of turbine design, the factors involved and how they influence the design are also covered. This discussion is a frank statement of the situation as one manufacturer of large turbines has found it, and should go a long way toward emphasizing the fact that the large turbogenerator is a commercial success and that there need be no engineering, manufacturing or economic hindrance to its use.

The steam turbine, with its extremely high peripheral speeds, enormous stored energy and concentration of large amounts of energy in a small space is so perfectly balanced, so quiet in operation and so completely enclosed that attendants are liable to overlook and ignore from familiarity what is going on inside the casing. Although the steam turbine is less spectacular than the reciprocating engine in that there is little noticeable movement, more skill and a higher grade of talent should be used with the former than with the latter, because of the higher operating speeds, the greater stored and available energy involved. Operating experience has proved that a defective governor or the careless manipulation of a unit by an attendant may result in stripping of blading, throwing the rotor out of balance, or unequal expansion, ending in damage or havoc to the machine. When one considers the small clearances between stationary and rotating elements, the intricate blading that is at best of a delicate nature, the high speeds, and that the whole is enclosed and entirely hidden from view, yet remains in service without inspection for weeks and months without shutdown, one can only wonder at the high degree of reliability attained by the turbine of today.

The steam turbine in all capacities has won a well-earned reputation for reliability. Mishaps that have occurred have been traced to causes that can and, it is believed, have or are being remedied. Because such a high degree of reliability has been attained is no reason, however, why carelessness in operation should be tolerated, nor why attendants should lose respect for momentum, centrifugal force, and so forth. The steam turbine, of the smallest or the largest capacities, possesses energy comparable to those of dynamite. Letting loose these forces may hinge upon a defective governor, something that did not work, or a careless attendant. Eternal vigilance, continual alertness, ceaseless carefulness and a high grade of maintenance are in the best interests of the turbine, those operating it and the service it supplies. Meanwhile, refinements in design go on and every mishap adds to the designers' knowledge of the materials that must be used.

The Combustion of Coal

THE combustion of coal is a chemical process. The extent to which efficiency is obtained depends upon the exactness with which the process is carried out. For perfect combustion, which means coal saving and the minimum expense for coal for the maximum amount of heat obtained from it, the boiler room must be a place where the chemical process of burning coal can be performed. The boiler room staff should become manufacturing chemists, and the facilities at their disposal similar to those of the chemist.

The chemist can do little in the way of uniform work, or in knowing what he is doing, without apparatus for making analyses, for weighing and for pyrometry. And what the chemist requires in the laboratory, so also the chemist needs in the boiler room. Without some at least of the wherewithal of the chemist, the boiler room force has the attributes of laborers rather than chemists, and an exact science becomes a slovenly performance. And coal economy suffers accordingly.

Where the chemist in the laboratory handles small quantities of materials under favorable conditions for their control and reaction, the boiler room force handles large quantities under adverse conditions. Accuracy and uniformity of results favor the former and make it the more difficult for the latter to obtain the correct chemical reaction, namely, perfect combustion. The way we burn coal in boiler rooms is at best unscientific, and lack of knowledge of how it is being burned usually adds to the farce. Meanwhile the waste of coal goes on.

On other pages of this issue Mr. June in his article entitled "Outline of Factors Governing Economical Boiler Operation," discusses the combustion of coal from the aspect of the chemistry involved. The best the boiler room staff can do is to supply the right amount of air to the fuel bed, and combustion then takes care of itself. Actually, supplying the exact amount of air so that the loss due to excess air is a minimum and yet no loss occurs due to deficiency of air, is quite a problem. It is like obtaining smokeless-

ness efficiently, without needlessly admitting an excess amount of air.

To burn coal correctly, the process involved must be understood, and facilities must be available for use for enabling the process to be supervised and controlled.

The combustion of coal in boiler rooms as at present carried on is, at best, a clumsy and unsatisfactory process. However, the more the subject is understood, the more appropriate equipment is used intelligently, the more a mere mechanical process tends to approach one chemically and scientifically correct.

"For Your Tomorrow They Gave Their Today"

IN A graveyard in France, and there are many such scattered among the silent places, can be seen an epitaph that reads, "For your Tomorrow they gave their Today." There are no more beautiful lines than these, glorious for what they represent, beautiful for the sacrifice they imply, pathetic because so sad.

We owe a duty to our heroic dead. But, too, we have a duty to perform toward those that are with us still. That duty is less spectacular, less sentimentality attaches to it, it is less easily accomplished than our duty to our dead. There are many thousands of our manhood who never "got into the fight," less fortunate than those that lie in the graveyards of France in that they never "got across," more fortunate in that they are coming back again to live their lives. But that these men were not called upon to make the supreme sacrifice was chance, luck, destiny. The choice was not theirs. They did their duty, all that was asked of them.

All these men who gave up comfort and were ready to risk their health and life for the country's cause are now coming back, expecting to find a place in which to live in the country for which they were ready to die. They have a right to expect an opportunity to make a living. It is their birthright that a place exist for them. It is their due, earned by sacrifice, that they be able to take up again civilian life without handicap for their service to the nation.

Already unemployment is assuming a disquieting aspect. The country is not taking to the work of peace as fast as it had been expected it would. Returning soldiers and sailors are finding difficulty in reverting to conditions they knew before their country called them. Bread lines are ominously mentioned as something in the not distant future. These things should not be. Returning soldiers and sailors must not be allowed to become objects of charity or subject to objectionable influences. They need not be found careers—they must make them for themselves when given an opportunity to earn a living.

To find work for those that stood ready to offer their lives in the country's cause is our duty, as our privilege. It is a matter of justice, of honor and fair-play. It is not a matter of "business is business." It is not a matter of doing "something." It is an urgent obligation of doing all we possibly can. Our boys have done their duty. Let us do ours, ungrudgingly and now.

Government Takes Progressive Step Regarding Power Supply

ADVOCACY of the interconnection of electric power systems into comprehensive networks supplying extensive districts has been indulged in for several years, both in this country and in Canada and more recently in Great Britain. Much had already been done in this direction in many sections of our country through the initiative of far-sighted central-station executives and the movement received a decided impetus during the war due to the great importance of power supply in the production of munitions and due to the necessity for promoting fuel economy to the utmost. Both the Fuel Administration and the War Industries Board recognized that marked economy and increased reliability would result from shutting down of small, inefficient power houses and the taking over of their loads by large, well located and efficient plants. Of course, the emergency conditions prevailing prevented systematic and co-ordinated working out of the idea of centralization of power supply in any very large district, but enough was done here and there to show that the movement was a wholesome one in promoting economical and dependable power production and important conservation of one of our most vital resources—fuel.

To further this conservation scheme power surveys were undertaken in several districts, but conditions did not permit very comprehensive studies of this nature even in sections where the power demands were greatest. The need for such surveys was clearly proven, however, and it is pleasing to note that the Federal Government is eager to continue and broaden them. On other pages of this issue will be found mention of the request to Congress made by the Hon. Franklin K. Lane, Secretary of the Interior, for two appropriations of $50,000 and $200,000, respectively, to cover power surveys to be conducted by the Geological Survey during the next fiscal year. The first will be of a general character to develop principles that may be generally applicable throughout the country. The second is to be a detailed survey of the big industrial district of the north Atlantic states.

Extracts from Mr. Lane's letter to the chairman of the Committee on Appropriations that we publish on page 267 show that he has a fine grasp of the many economic advantages to be derived from more efficient power production, from utilization of unused water powers and from electrification of railroads. It is to be hoped that the appropriations will be passed and this constructive work undertaken as early as possible.

Week's Events

Proposed Power Resource Survey—Proper Recognition for Appliances in Tariff Revision—Central-Station Statistics

EDISON PIONEERS CELEBRATE THE INVENTOR'S BIRTHDAY.

Early Associates of Edison Give Him Reception Before Departure for Short Vacation in Florida—His Comments on Business Policy.

In honor of the 72nd birthday of Thomas A. Edison, his early associates in inventive and industrial development work prior to 1886 planned to give him a luncheon on Feb. 10, just before the great inventor was leaving for a few weeks' much needed rest at his plantation near Fort Myer, Fla. Knowing his retiring disposition and avoidance of even very informal celebrations in his honor, they secured the co-operation of Mrs. Edison in having the start for the Florida trip made about an hour earlier than was actually necessary. Mr. Edison was spirited into the Robert Treat Hotel in Newark, N. J., where the extra hour was very pleasantly spent in a surprise reception given by the Edison Pioneers, which is the name of the organization of Mr. Edison's associates up to 1885.

Mr. Edison was in excellent health and vigor and was keenly delighted to meet his friends of the old pioneer days. Reminiscences were exchanged about his early inventions and the struggles involved in perfecting them and making them entirely practical and commercial. Mr. Edison was induced to pose for a motion picture. During a lull in the merrymaking, Mrs. Edison gathered the old friends of her husband about her in a big circle and asked them to send to her what reminiscences and mementos they could of his early days. She wishes to gather them together in a collection that will make fascinating study some day for those who want to learn how much one man can crowd into a lifetime. Mr. and Mrs. Edison broke away from the handshaking in time to get to the train for the first vacation trip since this country became involved in the war, the inventor having been busily engaged for the last two years on very important and extensive researches for the Government, some of which are still occupying his attention.

The Edison Pioneers carried out their program of the luncheon, even though they could not induce their honored guest to stay. Francis R. Upton, the retiring president, spoke of the inventor's young son, Theodore Edison, who has evidently inherited his father's inventive genius as his last two years have been given over almost entirely to inventive work. Among the fifty or so who were present at the gathering of the Edison Pioneers were: John W. Lieb, the new president of the organization; F. R. Upton, W. J. Hammer, W. M. Brock, T. C. Martin, W. Howell, Chas. L. Clarke, H. A. Campbell, Philip H. Kline, A. E. Winchester, C. A. Estabrook, Mr. and Mrs. Charles Edison.

A few days before his departure for Florida, Mr. Edison granted an interview to a number of newspaper men, to whom he told of his hopes of attaining the hundred-year average age of his great grandfather, grandfather, and father. Speaking of the problems of reconstruction, he said: "The first thing to do is to find jobs for all the fighters and workers who helped to win the war. This will be easy enough, if public officials everywhere will resume making permanent improvements and business men go ahead promptly about their respective businesses. The buying public is hungry for goods of all kinds. The purchasing power of the people is enormous and they have absolute faith in the future. The only danger is the business man who thinks he is longheaded and hangs back when he ought to go ahead. There is such a thing as being too shrewd and too close a bargainer.

"In Wall street the man who tries to buy at the lowest point and sell at the highest usually gets left. It is the same way in business. Readjustments in prices are already in progress, but the man who lets his business run down at the heel waiting for prices to reach their lowest level is likely to lose a great deal more than he gains, and even if he should happen to strike it lucky and make a little higher profit Uncle Sam will take part of this extra profit in taxes, so that the percentage is pretty heavy against the business man who lets his business stagnate in order to gamble on lower prices.

"I believe in business prudence, but right now I think the most prudent thing a business man can do is to go ahead. He should not be afraid to go after orders and buy the materials that he needs to fill them."

PROPOSED GOVERNMENT INVESTIGATION OF POWER RESOURCES.

Secretary Lane Asks for Appropriation of $200,000 for Power Survey of District Between Boston and Washington—Water Power and Railroad Electrification.

Secretary of the Interior Franklin K. Lane has asked Congress to appropriate $50,000 for a general survey of power production and distribution in the United States, including the investigation of methods for the further utilization of water power; he has also asked for an additional appropriation of $200,000 for a special investigation and report on the power supply in the industrial region between Boston and Washington to determine the economies resulting from a comprehensive system for the generation, transmission and distribution of electricity to transportation lines and industries. Both the proposed investigations are to be made by the Geological Survey and the appropriations are to cover the work during the fiscal year ending June 30, 1920. The general survey is intended to form the foundation for broad studies of the production of power throughout the United States to ascertain the best methods of power production. The special and more detailed survey of the North Atlantic seaboard is intended to help solve the more acute power problem of this great industrial region, and to

develop principles that will in a large measure be applicable to other sections of the country.

In a letter to Swagar Shirley, chairman of the House Committee on Appropriations, Mr. Lane said:

"That there is opportunity for a system of power supply far more economical and efficient than that now existing in the areas under discussion can not be doubted. It has for its central idea the development of a plan for the generation and distribution of power on a scale far more comprehensive than now exists in this territory and the more efficient use of the power in industry and in transportation.

"This result will be accomplished through the interconnection of existing power centers by means of a trunk-line transmission system of high efficiency. Into this trunk line energy will be fed from hydroelectric plants and steam-power stations located at tidewater and near the coal mines. From it will be taken the power required for each principal industrial center and for the electrification of trunk-line railroads and of such branch lines as may be located in metropolitan districts.

"Such a comprehensive system of power supply, making use as it would of unutilized or undeveloped water power and of fuel now wasted at the mines, will result in large savings in coal. A very large amount of coal now consumed by steam-power plants can be replaced by the development of water power. Fuel power can be developed near the mines and the wasteful transportation of coal by railroad to that extent avoided. I am reliably informed that as a conservative estimate 50% of the fuel now used by the railroads in this territory can be saved through the operation of trains by electricity instead of by steam locomotives, because of the much higher efficiency that can be obtained in the economical central station in comparison with the wasteful steam locomotive.

"The transmission of this energy as electricity instead of the hauling of coal by rail will relieve the railroads of this territory of an enormous freight burden, thereby making available transportation for the hauling of other commodities. This is a matter of far-reaching importance. Not only would the railroads in the immediate territory be relieved of hauling the coal for their own locomotives, but other railroads supplying them with coal would be relieved proportionately. This easing of the present strain on trackage and equipment would result automatically in an increase in transportation facilities, the necessity for which the country is now facing.

"Such a comprehensive system of power supply will give opportunity for the more continuous use of existing power plants through the operation of the diversity-factor; that is, power for which there is no demand at a certain time in one locality can be transmitted to another locality needing power at the moment. Spare units in one power center can then be used to assist other power centers in case of emergency or breakdown. A large amount of spare capacity can thus be brought into service and the capital already invested in existing power stations thus made more productive.

"That such economies and efficiencies can readily be obtained has been amply demonstrated by the repeated application of these principles to local situations. It is my conviction that they can be applied regionally with even greater success. My purpose in asking for the appropriation is to make possible the investigation necessary to their practical application in this particular region. The report to follow would present a definite plan for development and estimate accurately the savings to be effected.

"I am urging the earliest possible action, because I believe such a plan should be formulated at once before we enter upon a new period of industrial activity, so that the new construction that will be required may be co-ordinated with such a plan and developments that will not harmonize with the plan may be avoided."

ELECTRICAL SUPPLY MANUFACTURERS ACTIVE IN TARIFF REVISION.

International Trade Committee Busily Engaged in Securing Proper Recognition for Electrical Apparatus.

Work of the International Trade Committee of the Associated Manufacturers of Electrical Supplies is being pushed vigorously. It is essential that electrical equipment and supplies be given proper recognition and classification in the new tariff bill now being prepared by the Tariff Commission. The Committee advocates the inclusion of a separate schedule for electrical supplies in the bill and is making every effort to bring this about.

As the present tariff law specifically names but few items of electrical goods, all other electrical machinery, apparatus, appliances and supplies come under one of three provisions in which no consideration is given to the question of labor content. As this is often the chief and most variable element of cost, and as the principle on which the whole protective tariff is based is the difference in the labor cost at home and in foreign countries, it is absolutely necessary that this important element be taken into consideration in the framing of the new law. The committee, therefore, has gathered as much information as possible from the members regarding the approximate percentage of labor, material and general expense entering into the various products which it will use to demonstrate to Congress the need of a more satisfactory method of protecting the electrical industry.

The committee has also submitted a tentative classification schedule which may be adopted by the Government for reporting the volume of electrical products imported. exported and manufactured. This schedule covers only such part of the electrical industry as concerns the members of the Associated Manufacturers of Electrical Supplies as the remainder of the products will probably be taken care of by the Electric Power Club.

In this schedule all electrical apparatus, appliances and supplies are classed under the general classification number, 72. They are further classified as follows: 721, transforming apparatus and parts; 722, transmitting and distributing apparatus and supplies; 724, appliances and parts; 725, lighting fixtures and parts; 726, lamps and parts; 727, signal and communication devices and parts, not including measuring instruments and lightning arresters; 728, batteries and parts; 729, all other apparatus and supplies. These subdivisions are further subdivided into numerous parts for further convenience.

The committee has also been very active in preparing and distributing information of value to the members interested in foreign trade. At the request of the Board of Governors, Thomas M. Debevoise, counsel of the Association, recently submitted a letter relating to the Webb-Pomerene Act in connection with export trade, as follows:

"1. The Webb-Pomerene Act relates to export trade solely, i. e., trade or commerce in merchandise exported from the United States to any foreign nation.

"The word 'Association' wherever it is used in the act 'means any corporation or combination, by contract or otherwise, of two or more persons, partnerships or corporations.'

"2. The act declares that nothing contained in the Sherman law shall be construed as declaring illegal an association (as above defined) 'entered into for the *sole* purpose of engaging in export trade and actually engaged *solely* in such export trade or an agreement made or act done in the course of export trade by *such* association,' provided that trade within the United States is not restrained by such association or what it does.

"The legal danger from a combination under the act will undoubtedly be due to the fact that some competitor of the members, who does not desire to join the Association, feels that either his domestic or export trade has been hurt by the Association's activities. If membership in the association is always open to everyone in the same line of trade and the members

keep in mind that they must not infringe the rights of any competitor who does not wish to join with them, and if they further keep in mind that the Association must limit its activities to export trade, no trouble should be looked for.

"The purpose of this letter is to let the members know in a general way the provisions of the Webb-Pomerene Act so that they may decide whether by the formation of other associations they will take advantage of it."

The next meeting of the committee will be held Feb. 20 and among the speakers on that occasion will be Allen Walker of the Export Bureau of the Guaranty Trust Co., New York, and Pierce C. Williams of the Department of Commerce, Washington.

PUBLIC RELATIONSHIP KEYNOTE OF OKLAHOMA UTILITIES' CONVENTION.

Many Important Subjects Discussed by Prominent Speakers at Three-Day Meeting.

The relationship between utility companies and the public was one of the principal topics of discussion at the annual convention of the Oklahoma Utilities Association held at the Lee-Huckins Hotel, Oklahoma City, Feb. 6, 7 and 8. This and other subjects of vital importance were presented by able speakers and aroused considerable interest among the members.

The convention was opened by an address of welcome delivered by Governor Robertson of Oklahoma, to which J. F. Owens, vice-president and general manager of the Oklahoma Gas & Electric Co., Oklahoma City, and president of the Association, responded.

Among the principal speakers on Thursday were Hon. W. D. Humphrey, chairman of the Corporation Commission of Oklahoma, who spoke on the relationship of this commission and the public utilities, and John W. Shartel, vice-president of the Oklahoma Railways Co., on the "Electric Railway Development." Thursday evening two illustrated lectures were given, one describing the electrification of the Chicago, Milwaukee & St. Paul railway and another, entitled "A Square Deal for His Wife," depicting the various uses of electrical appliances in the home.

Friday morning E. J. Condon, president of the Condon Construction Co. of Chicago, spoke on "The Association of the Public Utilities and the Public." After this an inspection tour was made to the local packing plant of Morris & Co. where a complimentary dinner was served. In the evening a Jovian "Rejuvenation" was held.

The meeting on Saturday was opened with a discussion on "Rate Making," by E. F. McKay, rate expert of the Empire Gas & Fuel Co., Bartlesville, Okla. Following this the "Round Table" meetings of the various Bureaus were held. At the meeting of the Electric Light and Power and Electric Railway Bureaus many subjects of interest to central-station companies were brought out and discussed among which were the following: "Effect of Boiler and Switchboard Records on Efficiency of Operation," "Central Station and High Tension Distribution, *versus* Isolated Plants," "Possibility of Putting Generating Stations at Mines and Sources of Other Power and Distributing Through the State by a Network of High Tension Lines."

During the course of the convention a telegram from Col. H. M. Byllesby outlining his opinions on public ownership was read. In his telegram Colonel Byllesby called attention to the importance which this subject has recently assumed and recommended that it be given earnest, thoughtful and active consideration. While opposing public ownership except as a last resort, he heartily endorsed the regulation of utilities by commissions or other properly authorized bodies. The very best results, however, will be found as always in private ownership, where this ownership, while being regulated along proper lines, is still allowed full scope for the exercise of ingenuity and enterprise.

OREGON AND NEW JERSEY CENTRAL STATIONS REPORT INCREASES.

Census Statistics for These States Show Increases in All Branches Over 1912.

The central-station statistics for two more states, Oregon and New Jersey, have been completed and made public by Director Sam L. Rogers, of the Bureau of the Census, Department of Commerce. These figures, which will form part of the forthcoming quinquennial report on central electric light and power stations, were prepared under the supervision of Eugene F. Hartley, chief statistician for manufacturers. Previous reports of 15 other states appeared in the Jan. 4, Feb. 1, and Feb. 8 issues of the ELECTRICAL REVIEW.

The statistics relate to the years ending Dec. 31, 1917, 1912 and 1907, and cover both commercial and municipal plants. They do not, however, cover electric plants operated by factories, hotels, etc., which generate current for their own consumption; those operated by the Federal Government and state institutions; and those that were idle or being built.

The figures presented for Oregon are fairly comparable for 1912 and 1917. The decreases shown for the period 1907-1912 are due mainly to the fact that certain establishments reported as central electric light and power stations for 1907 were later taken over by electric railways and were therefore reported with them for 1912 and 1917.

CENTRAL-STATION STATISTICS FOR OREGON.

	1917.	1912.[1]	1907.	Per cent of increase.[2] 1907 to 1917.	1912 to 1917.
Number of establishments	68	66	61	11.5	3.0
Commercial	53	54	50	6.0	—1.9
Municipal	15	12	11	36.4	25.0
Income[3]	$2,577,297	$1,422,703	$1,965,245	31.1	81.2
Electric service	2,454,047	$1,380,785	$1,840,155	33.4	77.7
All other	$123,250	$41,918	$125,090	—1.5	194.0
Total expenses, including salaries and wages	$2,276,169	$1,205,738	$1,283,560	77.3	88.8
Number of persons employed	636	[4]532	467	36.2	19.5
Salaries and wages	$583,195	$387,119	$416,424	40.0	50.6
Total hp.	68,706	46,015	126,815	—45.8	49.3
Steam engines:					
Number	46	54	66	—30.3	—14.8
Hp.	27,062	15,879	24,581	10.1	70.4
Internal-combustion engines:					
Number	15	9	6	150.0	66.7
Hp.	578	334	182	217.6	73.1
Water wheels:					
Number	80	60	72	11.1	33.3
Hp.	41,066	29,802	102,052	—59.8	37.8
Kw. capacity of dynamos	47,917	32,416	32,587	47.0	47.8
Output of stations, kw-hr.	107,886,973	58,789,342	92,807,992	16.2	83.5
Stationary motors served:					
Number	3,284	1,527	2,072	58.5	115.1
Hp.	31,682	15,843	20,452	54.9	100.0
Number of street lamps:					
Arc	489	1,128	[5].....	.....	—56.6
Incandescent	10,363	6,239	[5].....	.....	66.1

[1]The decrease from 1907 to 1912 is due to the fact that certain companies, included among the central-stations for 1907, were later taken over by the railways and are included with the electric-railway industry for 1912. [2]A minus sign (—) denotes decrease. [3]Exclusive of $2,047,853 in 1917 and $2,327,822 in 1912, reported by street and electric-railway companies as income from sale of electric current. [4]Includes approximately 100 part-time employees. [5]Not available.

The report shows a pronounced growth in the amount of business done by the electric light and power stations of New Jersey. Their total income in 1917 was $23,480,320, representing an increase of 114.5% since 1912, as compared with an increase of 83.9% during the period of 1907-1912. The relative increase in the amount of current generated was greater at each of the five-year periods than the increase in the income for electric service or in that for the total expenses. The stations employed 5065 persons, to whom were paid salaries and wages aggregating $4,821,852. The rates of increase in the number of persons employed were 69.5% for the period 1912-1917, and 69.9% for the preceding five years, but the rates of increase in salaries and wages were considerably greater—94.5% and 80.9% for the later and earlier periods, respectively. The total primary horsepower, 96% of which was derived from steam engines, was 367,743 in 1917, an increase of 53.5% during the period 1912-1917, as against 155.9% for the preceding five years.

CENTRAL-STATION STATISTICS FOR NEW JERSEY.

				Per cent of increase.[1] 1907 to 1917.	1912 to 1917.
	1917.	1912.	1907.		
Number of establishments	63	64	64	—1.6	—1.6
Commercial	47	56	57	—17.6	—16.1
Municipal	16	8	7	128.6	100.0
Income[2]	$23,480,320	$10,944,367	$5,952,378	294.5	114.5
Electric service	$20,188,244	$10,387,513	$5,910,745	241.6	90.7
All other	$3,292,076	$356,854	$41,633	7807.4	822.5
Total expenses, including salaries and wages	$18,760,138	$9,348,864	$4,599,586	307.9	100.7
Number of persons employed	5,065	2,989	1,759	187.9	69.5
Salaries and wages	$4,821,852	$2,479,219	$1,370,506	251.8	94.5
Total hp.	367,743	239,514	93,602	292.9	53.5
Steam engines:					
Number	188	251	224	—16.1	—25.1
Hp.	353,021	235,585	90,480	290.2	49.8
Internal-combustion engines:					
Number	24	21	11	118.2	14.3
Hp.	12,665	2,360	1,328	853.7	436.7
Water wheels:					
Number	15	18	22	—31.8	—16.7
Hp.	2,057	1,569	1,794	14.7	31.1
Kilowatt capacity of dynamos	249,521	179,477	70,566	253.6	39.0
Output of stations, kw.-hr.	781,230,790	383,891,504	140,527,522	455.9	105.5
Stationary motors served:					
Number	30,679	12,772	5,994	411.8	140.2
Hp.	262,858	85,011	27,604	852.2	209.2
Number of street lamps:					
Arc	13,580	16,052	[3].....	....	—15.4
Incandescent, etc.	53,652	33,708	[3].....	....	59.2

[1]A minus sign (—) denotes decrease. [2]Exclusive of $42,313 in 1917 and $116,829 in 1912 reported by street and electric railway companies as income from sale of electric current. [3]Not available.

TELEPHONE COMPANY INSTALLS SUBMARINE CABLE.

Cable Laid Across Puget Sound from Seattle to the Navy Yards at Bremerton, Wash.

The joint meeting of the Portland Sections of the National Electric Light Association and American Institute of Electrical Engineers, held at Library Hall, Portland, Ore., on Feb. 4, was well attended, the feature of the meeting having been a paper by H. J. Sheppard, of Seattle, Wash., giving an interesting description of the installation of a deep-water submarine telephone cable across Puget Sound, for service between Seattle and the Navy Yards at Bremerton, by the Pacific Telephone & Telegraph Co. The matter was illustrated by lantern slides and moving pictures. This cable was laid in water 800 ft. deep and it is reported to be the longest submarine telephone cable in use in the United States. It was laid across four bodies of water, all different sections of the Sound, the cable weighing 9 lb. to the lineal foot. Steam tugs, equipped with donkey engines for operating the cable reel, were utilized in the work. There was also installed on the tug a motor-generator set to enable operators to apply electric brake control to the cable reel.

ACCOUNTING SYSTEM TO BE EXPLAINED TO MASSACHUSETTS CONTRACTORS.

There will be a special meeting of the Massachusetts State Association of Electrical Contractors and Dealers at the American House, Boston, Mass., Feb. 25, to which all members and non-members are cordially invited. At this meeting George J. Murphy, chairman of the Accounting Committee of the National Electrical Credit Men's Association will discuss the accounting system that has been adopted by the National Association of Electrical Contractors and Dealers. This system of accounting has the endorsement of numerous other electrical associations and it is expected that its adoption is another step in the correction of the weaknesses of the electrical contractors and dealers.

As this subject is of particular interest to bookkeepers and office help, an invitation is extended to these employes, especially the ladies, to attend this meeting.

PRELIMINARY STUDIES FOR SKAGIT PROJECT ARE BEING MADE.

A. H. Dimock, city engineer of Seattle, Wash., in his recent report to the City Council on the city's proposed Skagit river hydroelectric project, estimates the ultimate cost at not less than $30,000,000. The borings on Gorge creek and other sites, on which $80,000 have been spent, demonstrate that the depths to bedrock are much greater than was originally anticipated. A survey for the transmission line, from the proposed power site to Seattle, has been made over 42 miles of the 100-mile route. Plans require that either a railroad or an autotruck road, 30 miles long, be built from the Northern Pacific Railroad to the damsite, and studies of comparative costs of the two kinds are being made. Surveys along the river for the dam, tunnels, flumes and power plant have been made, and other surveys of the river canyon and Ruby creek reservoir site are to be made this coming season to supply data required by the Government.

UNDERWRITERS' LABORATORIES HOLDS ANNUAL MEETING.

At the annual meeting of the directors of the Underwriters' Laboratories, Inc., held recently at Chicago, reports for the year showed the institution to be in a very flourishing condition. William H. Merrill, Jr., the president, called attention to the valuable service that the laboratories had been able to render the government during the war, Mr. Merrill himself having been at the head of the Fire Prevention Section of the War Industries Board.

The following officers were elected for the coming year: Chairman of the board, H. C. Eddy, Commercial Union; president, William H. Merrill, Jr.; vice-presidents, W. C. Robinson, Dana Pierce, and A. R. Small; secretary, D. B. Anderson, and treasurer, L. H. Headen.

Commercial

Commission Advises Utilities—Record Sale of Factory Units —Electricity in War—Minneapolis Has Very Busy Month

UTILITIES COMMISSION OFFERS ADVICE TO PUBLIC SERVICE COMPANIES.

Chief Engineer of Illinois Commission Explains Importance of Proper Care of Complaints.

The following letter, which was recently sent to the public service companies of Illinois by Frank G. Ewald, chief engineer of the Public Utilities Commission of that state, contains some very pertinent advice, not only for these companies but for all companies which depend, to any extent, upon the goodwill of the public for their existence. The problem presented to such companies in establishing favorable public opinion is a difficult one and one which is especially important at this time. This advice, therefore, coming from one of the officers of a commission whose experience and success in this work are well known, deserves careful consideration.

The letter, in full, is as follows:

"As a result of the Commission's experience extending over a period of five years in meeting various problems involving the relations of public utilities with the public, we have become very strongly impressed with the large influence which the quality of service rendered and the methods of handling complaints exerts upon the character of this relationship with the public.

"During the recent times of stress, with the attendant scarcity of labor, there has been a tendency on the part of utilities to decrease the standard of service rendered, possibly with a view to more economical operation and possibly because of inability to adequately supervise the work of strange employes necessarily employed. Insofar as such a policy may have been intended, we believe that it is most unwise and that instead of operating to relieve the utility of its burdens, it will greatly increase them. We have seen this repeatedly proven during the past year.

"Through the handling of complaints most utilities find their only opportunity of meeting their consumers. This is unfortunate, because the utility gains its impression of its consumers through these complaints, which are often presented at times when the consumer is aggravated, and, on the other hand, the consumer gains his impression of the utility through the methods by which the complaint is handled.

"With the utility, the handling of complaints is a routine transaction which occurs with regularity, and the employes engaged upon this phase of the work come to regard the complaints merely as a part of the company's routine which is capable of being handled by routine methods, in much the same manner that material is passed through the stock room. With the consumer, however, a complaint is not a routine matter, but represents to him a real grievance. In other words, utilities are apt to regard a complaint as lacking individuality, while from the consumer's standpoint, each complaint has a very distinct individuality and stands out in his mind as a particular situation which merits individual attention.

"We have been frequently impressed with the fact that if a utility is willing to accord to each complaint an individuality and give it a just investigation, both from the consumer's and the utility's viewpoint, the complainant is well satisfied and, as a result of his contact with the company, has an appreciation of its human characteristics and a regard for its sincerity of purpose. A routine reply to some classes of complaints may be suitable, but its routine nature will usually impress the complainant unfavorably.

"The problem as to the future of public utilities is one which occupies considerable attention in the public mind today and is one which is of vital importance to the utility and to the public. We believe that much of the criticism directed against utilities and which, in a certain measure, re-acts against the regulatory bodies charged with their supervision, might be relieved by a broad-minded policy of handling complaints in which each case is treated as an opportunity for acquaintanceship with the consumer and each complaint is given an individuality and impartiality investigated.

"As the responsible executive of a utility, I hope that you will give the subject matter of this letter careful consideration. It is presented as a helpful suggestion regarding a vital matter and with the further idea that in many cases the operating heads of utilities inadvertently allow themselves to get out of touch with working details, some of which have a very important bearing upon the development of this complicated situation.

RECORD-BREAKING SALE OF LIGHTING UNITS DURING JANUARY.

Commonwealth Edison Salesmen Obtain Contracts for 1220 Factory Units to Improve Lighting Conditions.

The sale, or rental, of 1220 factory lighting units in one city in a single month to replace or be added to the existing lighting facilities is surely a big step towards the perfecting of artificial lighting conditions. To accomplish this when industrial conditions are as unsettled and uncertain as they are at present and in a community where the lighting conditions are far above the average is even more remarkable and should serve to stimulate the endeavors of other companies along these lines.

This record was established by the sales force of the Commonwealth Edison Co., of Chicago, during the month of January. This progressive central-station company was among the first to realize the need for better and more efficient lighting conditions in industries and in pursuit of this work has developed a number of practical lighting units to meet the various requirements. In addition to this work, numerous rental plans have been introduced to enable the pur-

chaser to obtain better lighting as easily as possible. This enviable record is the result of an intensive sales effort on the part of the sales department and the study which has been given this subject by the company's engineers.

The salesmen are especially trained in this work and devote practically their entire time to it under the supervision of O. R. Hogue, head lighting agent of the company. The value of proper training for salesmen in this work cannot be overestimated. The majority of factories to a certain extent are improperly and insufficiently lighted but in order to convince the manufacturer of this fact the salesmen must have sufficient accurate information not only to point out the advantages of good lighting from a physical standpoint but must be qualified to recognize poor lighting, the best methods of improving it and whether or not the manufacturer will receive any financial return for his investment. As a result of their training these men are able to explain to the prospective customer not only the needs and advantages of proper lighting facilities but can give him valuable assistance in the selection of suitable fixtures. This fact is evidenced from the high average intensity of 6 ft.-cdls. obtained

Sample of Lighting Unit Sold by Commonwealth Edison Co. for Industrial Lighting.

in the installations which were contracted for during the month.

Under the able direction of W. A. Durgin a series of factory lighting units, one of which is shown in the illustration, has been developed which are especially adapted for this work. Primarily, they are designed to give the best possible lighting effects but they also embody a ruggedness which enables them to withstand hard usage and simplicity to a sufficient degree to permit their being produced at a nominal price. The reflector is of punched steel, enameled, white on the interior and blue on the top. The stem is standard conduit in which an individual switch may be installed, if desired. To prevent the severe eyestrain which results from leaving the filament of the lamp exposed suitable shields made of opal glass, which soften the glare, may be attached over the base of the lamp. In addition, a lock-socket or sealing device is used to prevent the replacing of lamps except by authorized persons or the attaching of extension cords.

Of the 1220 units approximately 25% were sold outright for a nominal figure and the other 75% were distributed on the regular rental basis. Under the rental plan the customer agrees to pay a certain amount per unit per month as rental only, the current being charged for at the regular rates, for a period of two years, the company to do the necessary wiring and installing. At the termination of this period the customer may either renew the contract at a reduced charge, purchase the fixtures and wiring, or discontinue the contract. For a small additional amount the company will maintain, clean the fixture and make necessary lamp renewals. This latter clause cannot be too strongly recommended for it assures the proper care at all times, without which any equipment cannot maintain its highest efficiency and insures that the proper size of lamps which are originally installed will continue to be used.

ELECTRICITY AND THE WAR.

Brief Review of Importance of Electricity in Our Industrial Operations.

By A. Bellemain Cole,
Westinghouse Electric & Manufacturing Co.

Electricity is so essential that should one of the contending armies have been without this unseen force it would have been impossible for it to have existed long. So vital is this mystery of the ages that it may be said to have touched all of our preparations for war as well as actual combat. From the bowels of the earth we bring forth coal and oil, from which the latent energy of centuries is released for the generation of electricity to furnish power for vast industrial centers like Pittsburgh, or to propel a giant ship. Possibly a great cataract is harnessed and its energy used for the creation of electricity. In fact, our water powers, the greater utilization of which has been made possible by the advances in electrical engineering, are loaded to their limits—night and day—driving the mighty wheels of industry, turning out the sinews of war. In the Niagara district we have a singular illustration of how essential electricity has been in winning the war.

The cheap electric power produced at Niagara Falls made possible the founding of the artificial abrasive industry of the United States, and with the natural supply of energy and carborum from Asia Minor cut off by the war, where would we have been without Niagara's artificial grindstones, whetstones, and other grinding implements. In every plant where alloy and tool steels were used Niagara Falls' abrasives helped to win the war. In munition plants, in the locomotive works, in the automobile factories, in the foundries, in the machine shop will be found these abrasives, produced by the electric furnace, doing indispensable tasks.

The electric furnace has been of great assistance in the active prosecution of the war, particularly in the production of the rapidly growing quantities of high-grade steels from low grade, and of the alloys and metals which go into these steels, in process, such as ferro-silicon, aluminum, ferro-chrome, ferro-manganese, etc., in the production of artificial abrasives from bauxite ore, also the raw material for aluminum, which together with the high-grade tool steels, are essential in the working of those steels into high-grade tools and dies, into helmets, bayonets, rifle and machine gun barrels and high powered artillery; into sharpnel, high-explosive shells, armor plate; into various parts

of tractors, fighting tanks, auto trucks and airplane engines; into locomotives for transport behind the firing lines; into electrical machinery for the electric propulsion of battleships, battle cruisers and submarines; in the production of aluminum, a most important munition material, used independently or in alloys, such as with magnesium, another electric furnace product; in every Liberty motor and in other airplane motors, in airplane parts, in army canteens and cooking utensils, and the deoxidation of steel; in the production from coke and limestone of calcium carbide, the base material for acetylene and cyanide.

In the Southland, hydroelectric power drove myriads of spindles, weaving cotton into uniforms for our soldiers, bandages for the Red Cross and tents for our men at the front. In speaking of the great value of electricity in winning the war, it is significant in that here is a singular use that in many respects stands paramount. For war purposes the need of nitrates is almost as important as air and water, and in its ultimate analysis, a modern war is reduced to the simple terms of nitric acid. The nation engaged in a struggle for life and death becomes helpless the day nitric acid is exhausted, no matter what its population may be, no matter what their bravery, skill and resoluteness. To guard against our country being confronted by a shortage of nitric acid, at Sheffield, Ala., there is under construction a hydroelectric development to be used for the manufacture of nitrates. This will stand as one of the great achievements of the day. No less than 660,000 hp. will eventually be developed or more than all the power that can be obtained from the Niagara Falls on both the American and the Canadian sides of the Niagara River.

In the terms of the day, conservation is paramount, both in the utilization of man-power and natural resources. Think of the hundreds of thousands of tons of coal per annum these electrically harnessed streams will save for other uses. Far greater will this be felt when our great trunk-line railroads are electrified, thus eliminating the necessity for hauling locomotive coal, and alleviating transportation conditions as a whole. Electricity from our water falls driving our locomotives will increase the capacity of our railroads, making it possible to haul more freight per train and have more room for trains per mile of track. Coal, we must admit, is of vital importance in time of war, and any substitute becomes correspondingly important. No one has recognized this importance more than the officials of our national government in connection with winning the war. President Wilson has said regarding public utilization, and refers to the central station, the electric railway and the water powers: "It is essential that these utilities should be maintained at their maximum efficiency and that everything reasonably possible should be done with that end in view."

The integrity of the utility industry of this country has not only been preserved, but its activities have been speeded up to a point never hitherto attained, which has made it possible for us to take our places with the allies and be a final decisive factor in the termination of the world war.

The power companies had to keep pace with the extraordinary demands being made upon them to furnish electrical energy in large quantities to the shipyards, munition yards, to the airplane factories and to the innumerable industries engaged either exclusively in the manufacture of war products or of materials which ultimately become a part of war products.

The electric railways have hauled more freight, thus relieving the transportation situation. For nearly a century steam has moved our freight; more recently gasoline has been hauling many thousands of tons of freight in the direction of the battlefields of France. Electricity, the all powerful force, has been neglected as a means of hauling freight.

The electric railways are able to haul millions of tons of freight on thousands of miles of rails over which now hardly moves one car per hour.

The Chamber of Commerce of the United States fully realizes the importance of the electric railway as a valuable public utility and has asked authorities to give prompt and sympathetic hearing to utility petitions for assistance and relief due to the unusual financial conditions. Increased rates are of vital importance to the utility, but development of electric railway freight haulage is greater, to the public and to our Government.

JANUARY PROVES VERY BUSY MONTH IN MINNEAPOLIS.

All Branches of Minneapolis General Electric Co. Show Big Increase for Month.

In common with many other central-station companies, the Minneapolis (Minn.) General Electric Co. found January, 1919, an exceptionally good month as compared with the same month in preceding years. The gain in electric meters installed was almost four times as much as in January, 1918. The gain in kilowatts of lighting load connected was three times, and twice as much power business was added, about 500 hp. in motors having been put on the lines. There were about 250 already-built houses wired for electricity during the month, and the electrical appliance sales of the company show an increase of 32%. Special attention to house wiring, commercial lighting, commercial window display lighting, which should help to maintain brisk business, are planned for February.

As a result of the continued mild weather the output from the company's hydroelectric stations during the week ending Jan. 31 was practically double the output for the corresponding week last year. During the week the Sales Department secured 222 new electric light and power customers with 134 kw. of lighting and 145 hp. in motors.

SALE OF APPLIANCES IN LOUISVILLE GREATLY INCREASED.

Total of 14,449 Appliances Sold Representing 4300 Kw. Additional Connected Load.

Electrical dealers of Louisville, Ky., report combined sales of 289 electric washing machines, 1160 electric vacuum cleaners and 12,000 other electric household appliances during the year 1918. Most of these appliances, representing a load of 4300 kw., were added to the lines of the Louisville Gas & Electric Co.

The commercial department of this company during the week ended Jan. 31 secured 50 new electric light and power customers, with 26 kw. of lighting and 37 hp. in motors. New business contracted for shows an increase of 42 customers with 23 kw. of lighting and 333 hp. in motors. There was a gain of 14.5% in electric energy output over the corresponding week last year.

Operating

Cable Tunnels—Lateral-Strain Cable Tower—Feed-Water Treatment — Condenser Troubles — Boiler Room Facts

CONSTRUCTION OF TUNNELS FOR LIGHT AND POWER CABLES.

Abstracts from National Electric Light Association Paper.

By G. B. Springer.

In many cities it is necessary to build tunnels for conduit and cables under rivers or other bodies of water which may separate power plants from the distribution areas.

Armored submarine cables imbedded in the bottom of rivers have been used to some extent in the past, but trouble of various kinds and dredging up of cables have shown that it is more economical in the end to build tunnels, especially where many cables are to be installed.

In general, unless work of similar nature has been done in the vicinity of a proposed tunnel, it is best to have test borings made at the location of each shaft to ascertain the kind of material and the depth of rock. These borings can generally be made for $1.50 per foot, and where carefully done are valuable in locating the depth of the best material in which to build the tunnel.

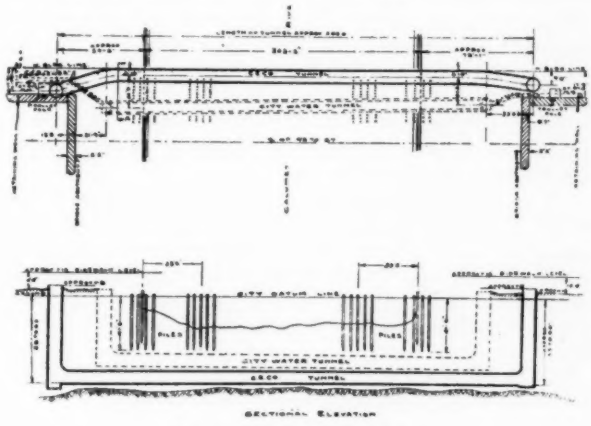
If a stratum of stiff blue clay is found of sufficient depth to permit the tunnel to be built and have from 12 to 15 ft. of good material between the roof and the river-bed, the tunnel can be built more economically than to drive it through rock. Where it is necessary to build in rock, it has been found that much more trouble results from water, both during construction and later. Water follows the fissures or faults in the rock, and under pressure resulting from an 80 to 90-ft. head it is difficult to handle and often results in a wet tunnel after work is finished. A depth of 50 to 60 ft. below water level for the top of the tunnel is desirable in order to avoid foundation piles for bridges, etc.

In excavating the shafts, steel rings ¾ by 4 in. are used to hold lagging in place, which is usually matched white pine 2 by 6 in., 4 ft. long, each set being put in place after 4 ft. is excavated, until the required depth is reached.

In cases where quicksand is encountered, it is often necessary to use steel shields or cylinders which can be sunk by the application of sufficient weight on top. In swelling clay or other unstable material where the ordinary method of using steel rings is impracticable, it is necessary to timber the shaft until good ground is reached. A square shaft with 12 by 12-in. timbers, well braced and backed up by 2-in. sheeting, will be found best for these cases.

When rings are used, wooden drums approximately 1 ft. smaller than the excavation are placed inside and the annular space filled with concrete. Four feet is a convenient height for the drums, the concrete being well tamped every 8 to 10 in. A mixture of one part of portland cement, three parts torpedo sand and five parts crushed limestone is a good proportion for the concrete. Material should be furnished according to approved specifications and should be tested as a check, especially cement.

Excavating and concreting the tunnel are usually done by using wooden forms of the section desired, set about 12 ft. apart, a space for the concrete being left between the lagging and the clay or rock, as in building the shafts. In some cases it is advantageous to use steel forms, such as bent channel iron, leaving more working room in the drift. Small cars on a narrow railroad are used for conveying the excavated material to the shaft, when it can then be raised in a bucket or on an elevator. The same railroad is used to carry the concrete to the heading. The lines and



Plan of Proposed Tunnel.

levels, especially where curves are necessary, should be given for each form. Small lines may be swung on each side of the shaft, a transit instrument being set on line below and the proper angles turned. A line of levels is transferred from above and stakes set every 10 to 12 ft.

The accompanying illustration shows a plan of a proposed tunnel which had to be built as far as possible from an existing tunnel and still remain inside the street lines. As the shafts could not be built on the same line as the tunnel on account of obstructions, an 85° curve 45 ft. long with a radius of 66 ft. was run on one side and an angle of 9°-and 6′ for 35 ft. on the other, thus connecting the shafts with the straight tunnel. Careful engineering was required in running the curve and bringing the two sides of the tunnel together in the middle. A railroad curve was figured and laid out by tangent offsets and offsets from the long chord, and the lines checked with a variation of only ¾ in. Work of this nature must be done with mathematical correctness, as a mistake in alinement may be very costly.

When the tunnel and shafts are concreted, they should be plastered with portland cement mortar mixed one part of cement and one part of fine sand or powdered stone. Small leaks may be stopped by adding soda ash to the mortar. Leaks which cannot

be stopped by plastering are trained to one point where a small pipe is inserted and after the plastering is finished the pipe is plugged.

Three-inch galvanized angle-irons are placed 4 ft. apart vertically and about 2 ft. from each side of the shafts, making two segmental spaces which are filled with ducts. As many ducts as are necessary can be built in the tunnel, and the number added to as needed. Vaults at the top of shafts should be larger than ordinary to facilitate the handling of a large number of cables. A 6-ft. tunnel, for example, should have manholes at the top of shafts about 15 by 15 ft. in size.

Smaller and less expensive tunnels are sometimes built under land where permission is not easily obtainable or where it is not practical to make open cuts.

COMBINATION STRAIN TOWER AND LATERAL.

Chicago Surface Lines Employ Interesting Line Construction for Railway Feeders.

Feeders leaving many of the substations operated by the Chicago Surface Lines, operating the street cars in Chicago, are both numerous and of large cross-section. While many of these cables are installed underground, many more are strung aerial as soon as possible after leaving the substation. In some instances the feeders travel underground only a short distance from the substation. In this latter case, many conductors of large cross section emerging close together are rather objectionable.

The accompanying illustrations show the way in which the Chicago Surface Lines employ a length of enclosed rigid I-beam as a combination lateral and strain tower, and by so doing get away from practically every objection to bringing out many heavy conductors in close proximity from underground to aerial.

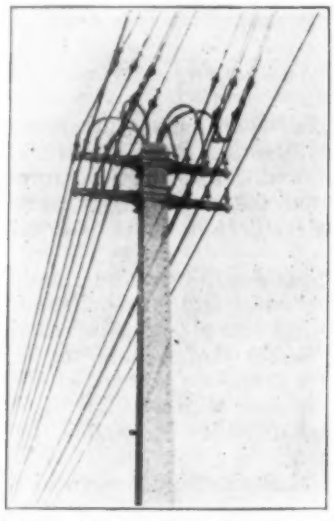


Fig. 1.—Combination Strain-Lateral Tower Employed by Chicago Surface Lines for Heavy Underground Cables Taken Aerial.

Fig. 1 shows a lateral-strain tower used with six cables emerging from a substation, and Fig. 2 indicates the arrangement of the six cables.

The tower consists of an I-beam imbedded in a concrete foundation. On the two "open" sides of this structure are bolted, one on each, sections of ¼-in. sheet iron, each section about 4 ft. in length. Malleable-iron crossarms are clamped to the top of the structure by bolts similar to U-bolts. Three cables are carried up inside the structure on each side of the I-beam and are tapped on to the aerial feeders on the line side of the crossarm insulators, as shown in Fig. 1. The

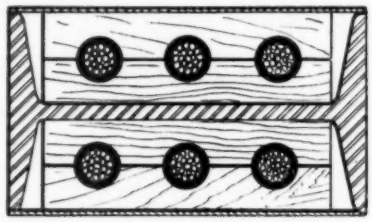


Fig. 2.—Arrangement of Cables as They Run Up in the Tower.

feeders dead-end at the strain tower and are guyed through strain insulators to a tower a span away in the opposite direction to that which the feeders follow.

The above arrangement permits the six conductors to be better protected from mechanical injury than were each cable brought up aerial in a lateral. The installation is less unsightly, and the I-beam acts as a strain tower as well as a lateral.

ELIMINATING OIL FROM FEED WATER.

Electrical Treatment of Feed Water Surpasses All Other Methods.

The importance of perfectly clean feed water for steam boilers free of oil is generally appreciated by operating engineers. Appliances ordinarily used do not succeed in completely removing the oil, because it is in an emulsive state and divided into globules of less than 1/1000 mm. diameter which can pass through the finest filtering medium. Various precipitants are employed, but success depends in every case on subsequent filtration of the water through large sand filters.

A new method has recently been developed, by which electricity is used, and with results obtained in no other way. The tiny globules of oil can be made to coalesce by passing an electric current through the water, and an apparatus has been designed for this purpose, using continuous current at 110 volts while the water flows through the feed pipe. The electrically treated water is then sent through a pressure filter consisting of perforated cylinders covered with cloth and enclosed in a strong vessel provided with inlet and outlet stop valves. Such a filter has very little effect on ordinary feed water, but, as the electric process described above causes the oil-globules to coalesce, the whole of the oil is effectively retained, leaving pure water only to pass through. A pressure gage on the filter indicates the condition of the filter cloth, which should be changed when the filters are changed.

PECULIAR CONDENSER TROUBLE.

Eliminating Effect of Vibration Solves Problem.

In a central station containing several 3000-kw. and two 12,000-kw. turbogenerators trouble began to develop in the condensers of the two 12,000-kw. units. These two condensers were of identical design, each having 4162 tubes, 21 ft. 6½ in. in length. Two center stay plates were installed across the length of the condensers.

The trouble which took place in the top half of the condensers only was that the tubes wore down very

badly and became perforated where they were held by the stay lace packing. The result was that a considerable leak took place into the steam space, and the turbines had to be taken out of service frequently in order either to renew the tubes or plug up the perforations, the former an expensive undertaking and somewhat difficult one because of the high price and shortage of condenser tubes, the latter an annoying and inconvenient maintenance job.

Vibration was the cause of the trouble, and the vibration was the result of the impact of the steam among the top nest of condenser tubes. The remedy was simple and consisted of removing the top third of the tubes and rethreading them through the center tube plate one hole out of pitch vertically so that the tube was then slightly hogged. This simple expedient overcame the trouble.

Another difficulty that developed in the plant in question was that of condenser tubes bulging inwards, the cause of which was that the ferrules had been tightened down on the stay lace packing. Expanding the condenser tubes slightly into the ferrules so that a metal to metal joint was formed overcame this trouble of inward bulging tubes.

PRACTICAL PHASES OF BOILER ROOM PRACTICE.

Economies Obtained and How They Were Brought About.

What can be accomplished toward improving boiler-room performance when the matter is tackled seriously, was dealt with in a paper, entitled "Practical Phases of Boiler-Room Practises," read by Edward Marshall, combustion engineer, Union Gas & Electric Co., Cincinnati, O., before a recent meeting of the Ohio Electric Light Association. In attempting to overcome the shortage of suitable boiler room labor, the scarcity and high price of coal, and the urgent necessity of not only maintaining plant capacity but increasing it, many interesting things were done and lessons learned.

Owing to these difficulties the handling of boiler room equipment has taken vast strides. Boilers were tested, and stokers reconstructed so that maximum capacity and efficiency could be obtained. Baffles were re-designed so that the very minimum draft loss, consistent with good distribution of gases, sufficed. Arches were changed by raising and lengthening them so that better combustion resulted; settings were torn down and rebuilt so that they would not leak air excessively and car loads of setting insulation were used, all with wonderful results; pipes that never had been covered were covered, as also were feed-water heaters, drum heads of boilers, pumps and engine cylinders. Boilers and stokers were tested so that the rating of highest efficiency could be determined. Instruments such as draft gauges, Orsats, pyrometers and CO_2 recorders were installed. Soot blowers, tube cleaners, Venturi tubes, water weighers, flow meters, were all installed with one object in view, that of bringing up the boiler efficiency in delivering to the switchboard the kw-h. for the least B. t. u. More attention was given to operating data than ever before; for example, boilers were never operated without some record being kept of the percentage of ash to the amount of coal burned; hours in service, that the proper time to clean boiler both inside and out could be known; whether more boilers were in service for a given load than is necessary. The old method of blowing down boilers two or three times a day a gauge or two was abandoned and some titration method used instead to determine when blowing down is necessary. This has shown in some plants that it is unnecessary to blow down boilers more than once in several days.

The data kept in most plants have been instrumental in bringing up the efficiency. In one plant keeping operating data enabled the efficiency to go from 32 to 68%. The plant consisted of four 400-hp. boilers set with inclination of tubes forward instead of back, with flue connection on front. These boilers were supposed to be baffled with "C" tile on the bottom row of tubes with a rear vertical baffle, with a baffle extending from drums six rows down on tubes midway between rear baffle and front headers. This plant was situated in a coal-mining region where coal was obtained very cheap before the price was fixed by the government, and very little, if any, attention had been paid to the efficiency up to this time. All at once some instruments were bought, stack thermometers were installed, showing stack temperatures between eight and nine hundred degrees; draft readings were taken showing draft of 0.8 in. over fire, Venturi tube was installed, and a crude method for keeping track of coal developed that only 3.3 lb. water per lb. coal was being evaporated; that the temperature of feed water was only 130° with sufficient exhaust steam blowing out through the roof to bring it up to 210°. One boiler at a time was gone over; it was found the bottom and rear baffles were practically gone, soot and flue-gas dust had accumulated on outside of tubes at both front and rear headers, that tubes above the first three rows were found to have not been bored for a period of three years. After re-baffling these boilers by using "T" tile in bottom row, taking out the vertical baffles and putting a baffle on top of the 8th and 14th rows, making a three-pass boiler, repairing the soot blowers, cleaning tubes inside and out, re-topping the stokers, installing new dump grates, it was found a draft of 0.35 in. could be obtained over the fire and the leaving gases were reduced below 600° and the amount of refuse in ash pit had been reduced from 40 to 15% and the efficiency of plant was increased from 32 to 68%. The saving in fuel by just applying some practical common sense methods was more than 50%.

Another problem that came up was checking up of the uses of the steam after it has been generated. A water balance of a plant indicates how inefficient some of the equipment is, and that the water rate on some of it is beyond belief. It may be found that a lot of steam syphons have been installed that attendants turn on and let blow for hours at a stretch; that the steam ejector is being used on a LeBlanc air pump because the vacuum cannot be held up without it; that the distributor is choked with sticks and stone; that some of the nozzles and blading on small turbines are worn so badly that twice as much steam is being used as should be; that the feed-water heaters have not the proper baffling and air vents to utilize and absorb the minimum amount of exhaust steam to give us the maximum feed water temperature; that the valve settings on the stoker engines, air compressors, dry vacuum, pumps, etc., are so far off that an excessive amount of steam is being used, and after checking up the amount of steam to the main units against the amount of water fed to the boilers to find the steam unaccounted for and the steam to the auxiliaries in some cases went over 33⅓%.

Contracting-Construction

Advantages of Three-Way Switches—Wire Combinations in Conduit—Why Building Should Resume—Test Connector

USE OF THREE-WAY SWITCHES REDUCES CURRENT CONSUMPTION.

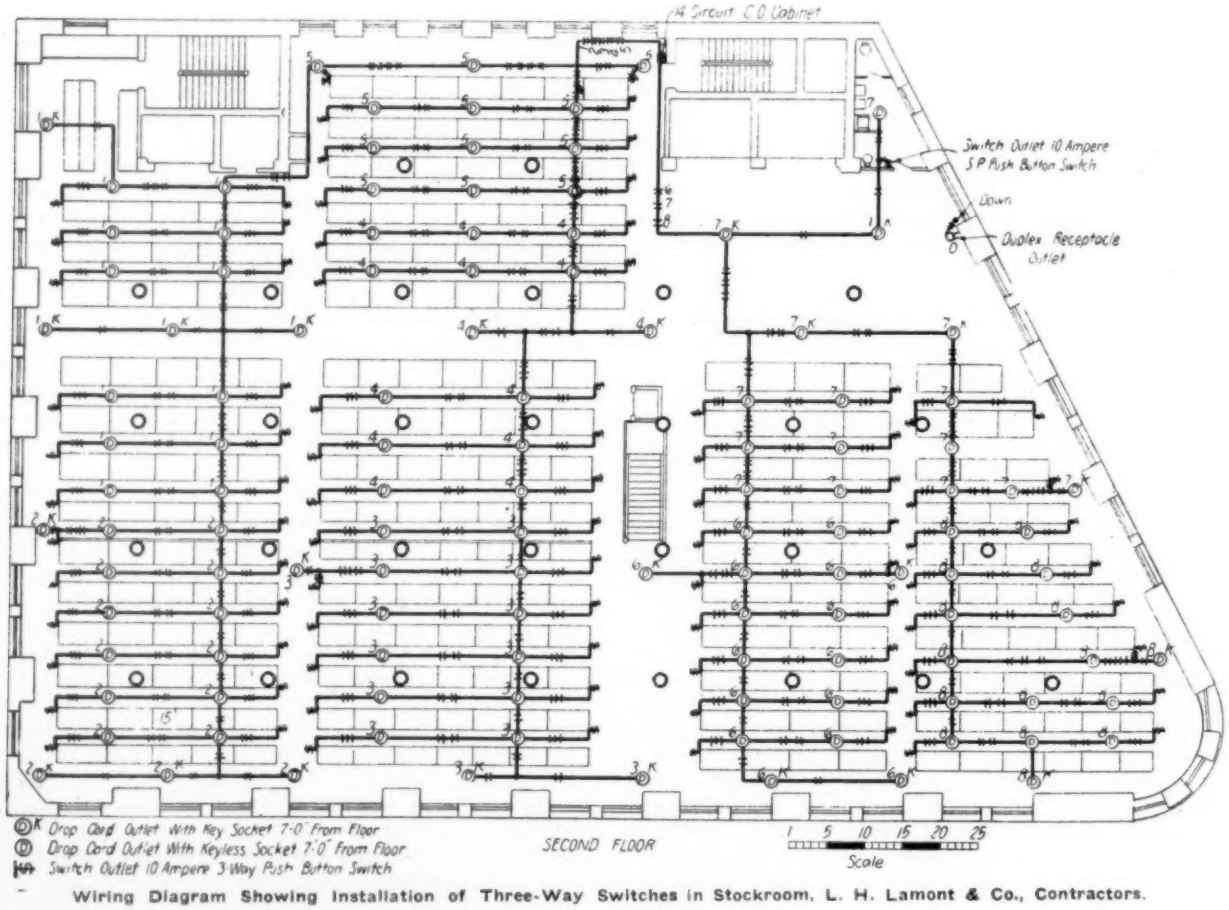
Elaborate Installation in Stockroom Also Improves Efficiency of Workmen.

A practical argument for the installation of 3-way switches in storerooms, warehouses, etc., is contained in the installation shown in the accompanying diagram. This installation was recently completed by L. H. Lamont & Co., of Chicago, for the Cluett Peabody Co. at its Chicago branch. In addition, the sketch shows very clearly the method of wiring and distribution by which the wire and conduit used were kept at a minimum.

The problem of providing adequate lighting for the numerous bins and stock shelves of this room, in which is kept a large stock of men's wear, and at the same time keeping the electric consumption as low as possible was a rather difficult one, especially since it was very desirable not to have the lighting arrangement interfere with the efficiency of the workmen. The nature of this stock is such that the orders invariably consist of a wide variety of different articles in small quantities. The individual orders are usually gathered by one man from the different shelves and taken to the wrapping table which is situated in the upper right corner of the room, as shown in the diagram.

If key sockets alone were used the man, in order to turn on the light, would have to drop whatever stock he was carrying at the time, turn on the light, pick whatever stock was needed, turn off the light and grope his way out in the dark, or the light would have to be kept burning. As it often happens that the stock from certain sections is needed but once or twice during the day, this latter method is of course not advisable as it would entail an unnecessary waste of current. As the workmen have adopted a progressive system of gathering the stock, by which they start from one point and fill the various items as they go along, single-pole switches could not be used to advantage as they would necessitate going back to the point where the switch was located.

This problem has been practically solved by the installation of 88 three-way switches, one at each end


Switch Outlet 10 Ampere
3 P Push Button Switch
Down
Duplex Receptacle
Outlet
Drop Cord Outlet With Key Socket 7'-0" From Floor
Drop Cord Outlet With Keyless Socket 7'-0" From Floor
Switch Outlet 10 Ampere 3-Way Push Button Switch
SECOND FLOOR
1 5 10 15 20 25
Scale

Wiring Diagram Showing Installation of Three-Way Switches in Stockroom, L. H. Lamont & Co., Contractors.

of the various tiers of stock shelves. As can be seen from the diagram, the workman is enabled to start from any point, turn on the lights in any tier by means of the three-way switch located near the entrance, pick the stock required from that tier and on leaving at the other end turn the lights off. Although slightly more expensive than the installation of single-pole switches or key sockets, the saving in current consumption is expected to repay this additional expense in a short time.

HAZARD FROM POOR ELECTRICAL MAINTENANCE.

Careless Changes and Upkeep of Lighting Circuit Cause Fire in Cotton Mill.

The electrician in charge of the operation and maintenance of electrical equipment and circuits in an industrial plant has considerable responsibility and dangerous possibilities result from his negligence. This, of course, is especially true in plants handling inflammable materials or in which there are large numbers of employes with little or no knowledge of electricity. An example of the serious trouble that may result from carelessness is cited in the last number of the *Quarterly of the National Fire Protection Association.*

In a cotton mill someone had pulled off an extension cord and fixture from an abandoned electric light connection, leaving the bare wires exposed. A sweeper in cleaning the ceiling and wire short-circuited the open ends. Sparks set fire to the lint on his broom, which he immediately dropped on the floor, where flames spread rapidly over parts of four slubbers. Cloth tacked on the ceiling to collect oil from the floor above aided the spread of fire along the ceiling. Fortunately fire sprinklers operated and practically extinguished the fire before it had an opportunity to spread generally and destroy the plant.

This case shows the evil of allowing anyone but the electrician to tamper with electrical equipment. It also shows that where rules to this effect are not strictly enforced, the electrician must make a much more frequent inspection of the circuits and apparatus. Above all things, bare circuit wires must not be permitted because even if they do not produce a bad fire, they may give a workman a shock that may result in serious injury.

DETERMINING WIRE COMBINATIONS TO BE INSTALLED IN CONDUIT.

Report of Rubber-Covered Wire Committee of Western Inspectors Contains Valuable Information on This Subject.

The report of the Committee on Rubber-Covered Wire of the Western Association of Electrical Inspectors presented at the recent annual meeting of the association is of considerable value to inspectors, contractors and engineers, inasmuch as it affords a means of standardizing the combinations of wires which may be installed in conduit. This report, which was read by V. H. Tousley, chief electrical inspector of Department of Gas and Electrcity of Chicago, not only embodies a very complete table of combinations but also the methods of determining such combinations.

The publication of the table of "Size of Conduits for the Installation of Wires and Cable," as contained in Rule 28 of the Code, has proven of great value to inspection departments and also to contractors and the engineering profession. A standardization of this kind is always beneficial and particularly so when it refers to a subject of such constant application as the one referred to. There is found, however, a constant demand for information on combinations of wires and conduits not given in the Code table and it is to supply this demand that the following tables have been compiled.

As the Code tables have been in use since the 1915 edition of the Code, and with no serious complaint against them, it is fair to assume that the values therein given are approximately correct, and may be used as the basis for an extension of the table. It may also be safely assumed that the largest wire, or combination of wires, to be allowed in a given conduit must bear a certain definite relationship to the conduit either in the relative diameters of the wires and conduits or in their relative areas.

The relative diameters and areas of the combinations permitted by the present Code are shown in the following table, which is based on the greatest number of wires of different combinations allowed in a given conduit.

MAXIMUM NUMBER OF WIRES ALLOWED IN CONDUIT—PRESENT TABLES.

Size of cond.	Comb. of wires.	Relative diam.	Relative area.
½	1-No. 6	66%	43%
¾	1-No. 1	72%	52%
1	1-No. 3/0	70%	50%
1¼	1-400,000 C.M.	75%	55%
1½	1-600,000 C.M.	76%	59%
2	1-1,000,000 C.M.	73%	52%
2½	1-1,500,000 C.M.	73%	53%
3	1-2,000,000 C.M.	65%	43%
1	2-No. 6	79%	27%
1¼	2-No. 2	76%	28%
1½	2-No. 0	79%	30%
2	2-600,000 C.M.	80%	32%
2½	2-900,000 C.M.	80%	32%
3½	2-1,500,000 C.M.	80%	32%
4½	2-2,000,000 C.M.	80%	32%
5			
½	3-No. 14	71%	30%
¾	3-No. 10	67%	29%
1¼	3-No. 3	78%	38%
1½	3-No. 1	81%	40%
2	3-No. 3/0	78%	38%
2½	3-300,000 C.M.	84%	43%
3	3-500,000 C.M.	81%	40%
3½	3-700,000 C.M.	80%	40%
4	3-1,000,000 C.M.	82%	41%
4½	3-1,250,000 C.M.	82%	42%
5	3-1,750,000 C.M.	83%	43%
6	3-2,000,000 C.M.	73%	32%
¾	4-No. 12	67%	30%
1	4-No. 8	67%	28%
1¼	4-No. 5	80%	40%
1½	4-No. 2	81%	41%
2	4-No. 0	77%	37%
3	4-300,000 C.M.	77%	38%
3½	4-500,000 C.M.	79%	40%
	SPECIAL TABLE.[1]		
½	2-No. 10	81%	32%
¾	4-No. 10	76%	38%
½	4-No. 14	81%	41%
¾	5-No. 12	75%	37%
1	10-No. 14	77%	37%
1¼	18-No. 14	71%	37%
1½	24-No. 14	72%	37%
2	40-No. 14	....	37%
2½	74-No. 14	....	48%
3	90-No. 14	....	38%

[1]See note at bottom of Code table. Rule 28i.

The values shown in this table are obtained by using the following dimensions of wire and conduit. An investigation of the tables of dimensions for rubber-covered wires, also for conduit, as given by the manufacturers, shows a considerable variation in diameters of both wires and conduit. The table which follows has been compiled from data supplied by a number of manufacturers and can be considered suitable for the purpose for which it is used. However, exact dimensions are not absolutely necessary, for they

are used only in a comparative sense in extending the table, and as long as the same dimensions are used both in the old table and in the extension of it, errors are eliminated.

DIMENSIONS OF RUBBER-COVERED WIRE.

	Diam.	Area.		Diam.	Area.
14	.20	.031	600,000 C.M.	1.23	1.19
12	.22	.038	650,000	1.27	1.27
10	.25	.049	700,000	1.30	1.35
8	.28	.06	750,000	1.33	1.39
6	.41	.13	800,000	1.36	1.45
5	.44	.15	850,000	1.40	1.54
4	.46	.17	900,000	1.43	1.60
3	.49	.19	950,000	1.46	1.68
2	.52	.21	1,000,000	1.49	1.74
1	.59	.27	1,100,000	1.61	2.04
0	.63	.31	1,200,000	1.66	2.16
00	.68	.36	1,250,000	1.68	2.22
000	.73	.42	1,300,000	1.70	2.27
0000	.79	.49	1,400,000	1.75	2.40
225,000 C.M.	.84	.55	1,500,000	1.79	2.52
250,000 C.M.	.86	.58	1,600,000	1.83	2.63
300,000 C.M.	.94	.69	1,700,000	1.88	2.78
350,000 C.M.	.99	.77	1,750,000	1.90	2.85
400,000 C.M.	1.03	.83	1,800,000	1.92	2.89
450,000 C.M.	1.08	.92	1,900,000	1.97	3.05
500,000 C.M.	1.12	.99	2,000,000	2.00	3.14
550,000 C.M.	1.19	1.11			

DIMENSIONS OF CONDUIT.

	Diam.	Area.		Diam.	Area.
½	.62	.306	3	3.06	7.34
¾	.82	.516	3½	3.56	9.94
1	1.04	.848	4	4.02	12.7
1¼	1.38	1.49	4½	4.5	15.9
1½	1.61	2.03	5	5.04	19.9
2	2.06	3.32	6	6.06	28.8
2½	2.46	4.75			

RATIO BETWEEN THE DIAMETER OF A CIRCLE ENCLOSING THE COMBINATIONS OF WIRES SHOWN, TO THE DIAMETER OF ONE WIRE.

2 wires—2 times diameter of one wire.
3 wires—2.2 times diameter of one wire.
4 wires—2.5 times diameter of one wire.
5 wires—2.8 times diameter of one wire.
6 wires—3 times diameter of one wire.
7 wires—3 times diameter of one wire.
8 wires—3.5 times diameter of one wire.
9 wires—3.8 times diameter of one wire.
10 wires—4 times diameter of one wire.
11 wires—4.16 times diameter of one wire.
12 wires—4.3 times diameter of one wire.
13 wires—4.4 times diameter of one wire.

Using the data shown in the first table, the following limiting dimensions have been assumed as representing the experience of the present Code tables and the extensions of these tables have been worked out on the following basis:

1 wire, 56% of the area of the conduit.
2 wires, 32% of the area of the conduit.
3 wires, 42% of the area of the conduit.
4 wires, 40% of the area of the conduit.
Above 4 wires, 37% of the area of the conduit.

The following illustrations will show the method used in determining the proper size of conduit where there are combinations of odd sizes of wires. As an illustration: What size of conduit will be required for 6-No. 8 and 6-No. 2 wires? The area of 6-No. 8 is $6 \times .06 = .36$. The area of 6-No. 2 is $6 \times .21 = 1.26$. The total area is $.36 + 1.26 = 1.62$. According to the table, 12 wires should have an area of 37% of the area of the conduit; $162 \div .37 = 4.37$ or a 2½- inch conduit.

It must be remembered that the data contained in this report do not replace or constitute a change in the present Code rules and in instances where it apparently conflicts with the present Code allowances, the Code rules must be followed. Several of these conflicts are evidently caused by the fact that in the Code table only double-braid wires are considered while in this table the dimensions of single-braid wires were used whenever such wires are permitted. It is also well when using the data contained in the report to bear in mind Rule *26p* which requires that except in the case of stage pocket and border circuits the same conduit must not contain more than four two-wire, or three three-wire circuits of the same system, except by special permission, and must never contain circuits of different systems. Furthermore, the rigidity of the wires will often prevent the practical application of the table.

MAXIMUM NUMBER OF WIRES IN CONDUIT.

	Size of Conduit.												
B. & S.	½	¾	1	1¼	1½	2	2½	3	3½	4	4½	5	6
14	4(*3*)	6	10	17(*18*)	24	40	57(*74*)	88(*90*)	118	151	190	237	342
12	3(*1*)	5	8	14	19	32	46	72	97	123	155	193	280
10	2(*1*)	4(*3*)	6	11	15	25	36	55	75	96	120	150	216
8	1	2	5	9	12	20	29	45	61	78	98	123	177
6	1	1	2	4	5	9	13	21	28	36	45	56	81
5	1(*0*)	1	1	3(*4*)	5	8	11	18	24	31	39	49	71
4	1(*0*)	1	1	3	4	7	10	16	21	27	34	43	62
3	..	1	1	3	4	6	9	14	19	24	31	38	56
2	..	1	1	2	3(*4*)	6	8	13	17	22	28	35	50
1	..	1	1	1	3	4	6	10	13	17	21	27	39
0	..	..	1	1	2	4	5	8	11	15	19	23	34
00	..	..	1	1	1	3	5	7	10	13	16	20	29
000	..	..	1	1	1	3	4	6	8	11	14	17	25
0000	..	..	..	1	1	2	3(*4*)	5	7	9	12	15	21
225,000	..	..	..	1	1	1	3	5	6	8	10	13	19
250,000	..	..	..	1	1	1	3	4	6	8	10	12	18
300,000	..	..	..	1	1	1	2(*3*)	4	5	6	8	10	15
350,000	..	..	..	1	1	1	1	3	4	6	.7	9	13
400,000	..	..	..	1	1	1	1	3	4	5	7	8	12
450,000	..	..	..	..	1	1	1	3	4	5	6	8	11
500,000	..	..	..	..	1	1	1	3	4	4	5	7	10
550,000	..	..	..	..	1	1	1	2	3	4	5	6	9
600,000	..	..	..	..	..(*1*)	1	1	1(*2*)	3	4	5	6	9
650,000	..	..	..	..	..	1	1	1	3	4	4	5	8
700,000	..	..	..	..	..	1	1	1	3	3	4	5	8
750,000	..	..	..	..	..	1	1	1	3	3	4	5	7
800,000	..	..	..	..	..	1	1	1	2	3	4	5	7
850,000	..	..	..	..	..	1	1	1	2	3	4	4	6
900,000	..	..	..	..	..	1	1	1	2	3	4	4	6
950,000	..	..	..	..	..	1	1	1	1	3	3	4	6
1,000,000	..	..	..	..	..	1	1	1	1	3	3	4	6
1,100,000	..	..	..	..	..	..	1	1	1	2	3	3	5
1,200,000	..	..	..	..	..	..	1	1	1	1	3	3	5
1,250,000	..	..	..	..	..	..	1	1	1	1	3	3	4
1,300,000	..	..	..	..	..	..	1	1	1	1	2	3	4
1,400,000	..	..	..	..	..	..	1	1	1	1	2	3	4
1,500,000	..	..	..	..	..	..	1	1	1	1	2	3	4
1,600,000	..	..	..	..	..	..	1	1	1	1	1	3	4
1,700,000	..	..	..	..	..	..	..	1	1	1	1	3	4
1,750,000	..	..	..	..	..	..	..	1	1	1	1	2(*3*)	4
1,800,000	..	..	..	..	..	..	..	1	1	1	1	2	4
1,900,000	..	..	..	..	..	..	..	1	1	1	1	2	3
2,000,000	..	..	..	..	..	..	..	1	1	1	1	2	3

Note.—There are several instances in which the above table conflicts with the code. Wher such conflicts occur the code allowances are designated by the italic figures in parenthesis.

CONTRACTORS SHOULD ENCOURAGE IMMEDIATE RESUMPTION OF BUILDING.

Prominent Architect Finds That Material Costs Will Fall Little and Labor Costs Not at All.

Contractors and others interested in the building industry are eager to present definite information to prospective clients on the outlook in building costs, the uncertainty of which is the only feature that now retards general resumption of much needed construction. The following article by George C. Nimmons, one of the leading architects of Chicago, on the building outlook, is of special interest because it embodies information gathered by him in the course of an inspection of the great port terminals in connection with the preparation of a series of articles for the *Architectural Record*, of New York:

"It is estimated that the cost of civil building construction postponed on account of the war, has now reached the sum of $3,000,000,000 and that it is equivalent to the average amount of building done in one year over the entire country. The reason most projects are now being deferred is that heavy decline is expected to take place in the cost of labor and building materials. Any trustworthy information, therefore, that can lead to any feeling of confidence generally as to just what this decline will be and when it will come is the information needed now to stabilize conditions and establish a definite program for the coming year's operations.

"Recently the writer had an opportunity of securing from many of the builders who are still engaged in the most important construction work now going on in this country, their statements and opinions as to the future conditions. This information was gathered during an inspection of the great port terminals and other war work. The consensus of opinion of all these men who are now most closely in touch with present conditions is that there will be a further drop in the cost of buildings, but that this drop will not be very material. The reason given for this was that, when some additional reductions in cost are made, sufficient building projects will go ahead to stimulate these prices and keep them at a level not far below where they are now.

"The building projects which will proceed will come from two sources. First, from industrial and commercial concerns whose business demands will justify expansion in buildings. In such cases the excess cost of buildings will often be taken care of by the resulting increase in business and charged off in a period of probably ten years. The other source of building will come from the federal and state governments. It was held that the growing sentiment for giving employment to soldiers and utilizing existing resources, will soon result in creating legislation for a vast amount of construction. The average yearly cost of such work is $600,000,000, and there is talk of doubling that.

"Additional reasons given for the above statements were that labor will not come down in price, according to Samuel Gompers and the building trades organizations, and that for over twenty years, in spite of all panics and hard times, the cost of labor for building has steadily advanced. Part of the cost of producing building material is labor, for the price of which there is little prospect of decline.

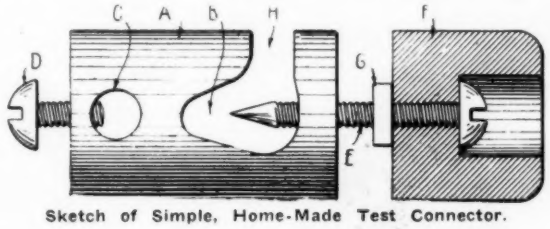
"As to the best method of securing the bottom price for any building project, the opinion seemed to prevail that an owner could only secure whatever deduction there may be made by going into the market with plans completed ready to buy; that material men and contractors will hold back their price cutting until there is positive evidence in the completed plans of really getting a job.

"It appears, therefore, according to these authorities, who are so closely connected with the present building situation, that any one desiring to build is not likely to secure any material reduction in cost by deferring the beginning of such work for a number of years. Their opinion was that the ones who started first would gain a greater reduction in the small profits which idle builders would at first accept than the saving there may be in cost from reduced prices of materials later after the builders generally have secured enough work to engage their organizations."

AN EFFECTIVE AND EASILY MADE TEST CONNECTOR.

By J. A. Weaver.

In making tests or whenever there is occasion to establish temporary connection to existing wiring with a minimum of time and effort, where the conductors are "live" or where it is undesirable to remove the insulation, the test connector illustrated will be found very convenient and effective. The materials needed to make it can be found in the scrap collection of the average shop. The size of the device will, of course, vary according to the sizes of wires to be used.



Sketch of Simple, Home-Made Test Connector.

The body *A* can be either of round, square or hexagon brass rod. The opening *B* extends through the center of the body and is made of an elliptical shape by filing, so that wires of different diameters will be centered properly and allow the pointed steel screw *E* to engage the wire squarely after piercing the insulation. The wire enters the opening *B* through the slot *H*, which should be of sufficient width to accommodate the largest size wire to which it is to be applied. The hole *C* is for the attachment of the test lead, and the screw *D* is to clamp same. The handle *F* is made of round fiber rod and, as the section shows, is countersunk for the steel machine screw *E* which is screwed tightly into the threaded hole and further locked in position by the locknut *G* which may be soldered to the screw if desired.

This connector possesses the advantage of being able to apply easily with one hand when working in difficult places. The pointed screw can be quickly removed and sharpened when necessary. The contact made by this screw will carry a fairly large current, but if a very heavy current is to be carried the wire should be bared so that the contact is established by the face of the slot. When it is once applied no amount of jerking will affect it. If care is used in tightening the screw, there is little danger of nicking the wire seriously, not as much as carelessly skinning the wire with a knife.

New Appliances

Locking Guards—Marine Fittings—Mica-Insulated Coils —Universal Fans—Grinding and Polishing Motor Outfits

New Hubbell Locking Guards for Reflectors.

A new line of locking lamp guards for use with reflectors is about to be placed on the market by Harvey Hubbell, Inc., Bridgeport, Conn. As shown in the accompanying illustrations they are

New Locking Guard of Strong Construction.

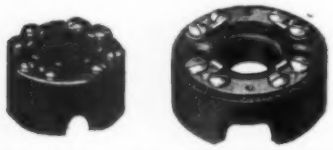
radically different in design from this company's other types, but possess the same rugged strength due to the sturdy wires and electrically welded joints. The wires are of steel, heavily tinned before being welded. The locking device draws the guard tight around the reflector, making the outfit practically one unit and absolutely insuring the protection of the lamp against both breakage and theft. These guards can be readily

Locking Guard Atttached to Reflector.

adapted to slight variations in reflector sizes. Two keys are furnished with each standard package of guards, which are made for four sizes of reflectors, 6½, 7, 8 and 10 in.

Marine Connecting Block and Cartridge-Fuse Base.

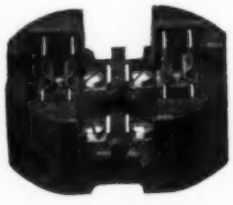
The Bryant Electric Co., Bridgeport, Conn., which manufactures a comprehensive line of marine wiring devices, has ready for the market new



Bryant Marine Connecting Blocks Nos. 577 and 593.

interconnecting blocks, which are here illustrated and identified by catalog Nos. 577 and 593. These blocks are made of unbreakable composition and provide means for making connections for branch circuits in junction boxes without the labor and difficulty of making soldered and taped tapoffs. The terminal plate binding screws are long and heavy and "staked," so that they cannot drop out and be lost. A center hole provides for wire entrance from the back of the box, if necessary, and the large groove in the base permits wires to pass through under the block. The dimensions of the No. 577 are diameter, 1¾ in.; height, 1 in. The No. 593 block is 2¼ in. in diameter and 1 in. maximum height. Brass fastening screws are furnished and kept in place by holding washers. Screw spacings are 1⅜ in. on centers, which is standard on all Bryant marine devices.

The cartridge-fuse base (catalog No. 576) which is also made of unbreakable composition, provides a means of fusing a circuit in a regular 4-in. junction box. Binding screws are amply long and "staked" so that they cannot drop out. Hole in center provides for wire entrance to the



Bryant Marine Cartridge-Fuse Base.

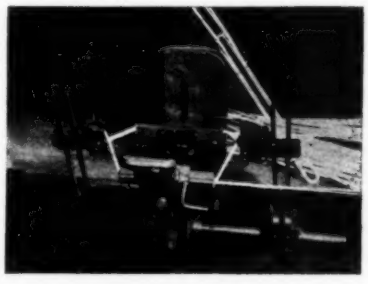
back of the box. As will be noted, there is ample room between the fuses for additional circuits to pass through the box. Size 6-32 brass fastening screws are furnished and kept in place by holding washers. Holes for screws are 1⅜ in. on centers. Dimensions of the fuse base are 3¾ in. diameter, 1⅜ in. high. National Electrical Code standard cartridge fuses are used in this block.

Mica-insulated Armature Coils for Alterators.

Failure of armature-coil insulation is the most common single cause for generator shutdowns. These are invariably expensive, either through loss of revenue, or repair charges, or both. A perfect insulation—one that never fails—is, at present at least, unknown.

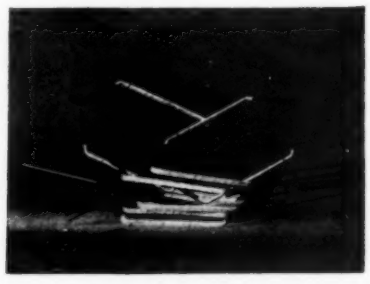
By a happy choice Westinghouse engineers decided more than twenty years ago on mica as the best available material for the purpose. The Westinghouse Electric & Manufacturing Co. and some other manufacturers are now finding mica a solution for some of the problems of the large-capacity, high-voltage and high-speed designs demanded by the up-to-date power plant.

Mica is a first class dielectric. Its insulation resistance increases with tem-



Pulling Machine Used to Form Armature Coils for Westinghouse Alternating-Current Generators.

perature, a valuable characteristic for higher temperature work, and in direct contrast with the properties of treated tapes, in which the insulation resistance and loss increases rapidly at temperatures above 100 degrees. It is



Armature Coils After Impregnation and with Wrapper, Hand-Applied and Taped.

unaffected by temperatures far in excess of those encountered in the modern, well ventilated alternator. It is impervious to the static discharges present in all high-voltage machines. It is resilient and retains its resiliency indefinitely, thus helping to hold the coil tight in its slot.

Mica is a mineral obtained in the

Completed Coils After Being Wound with Mica.

form of large crystals. These split readily into thin, parallel-sided laminas, or flakes. The flakes are pasted uniformly on cloth or paper to facilitate handling and to provide a mechanical support during application.

In the form of a "wrapper," i. e., pasted on large sheets of specially treated paper, mica is used on all Westinghouse alternating-current generators on the straight sides of each armature coil, to provide insulation between conductor and iron, the operating voltage of the machine determining the number of turns, or the thickness of this insulation wall.

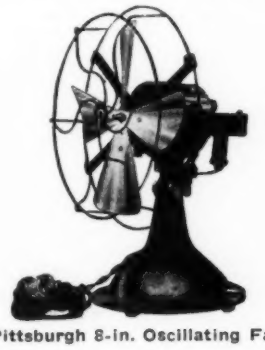
All known insulating materials are relatively poor heat conductors. This is equally true of mica and treated tapes. Therefore the tighter and the thinner the wall, the better the heat-radiating characteristics of the coil. For the lower-voltage machines the mica wrapper is applied as tightly as is possible by hand. For the higher-voltage windings, in general 6600 volts and above, where the insulating wall must be relatively thick, special, patented machines are used which apply the wrapper under heat and pressure, and finish it to a solid, compact wall.

In general, all of the larger-capacity generators have relatively wide cores. Internal "hot spot" temperatures, considerably higher than those measurable by thermometer, exist. On all such machines, each conductor of the coil is also insulated with mica tape, and in many cases each individual strand or wire of the conductor as well.

Pittsburgh Fans with Universal Motors.

To be of the widest possible service an electric fan that can be employed on either direct-current or alternating-current circuits possesses important advantages over one that can not be used interchangeably. This idea has been carried out in the line of fans being marketed by the Pittsburgh Electric Specialties Co., 396 Broadway, New York City. All its 1919 fans are equipped with universal motors. With the exception of two types, the company's fans are wound for 32, 110 and 220-volt circuits. In the 1919 line are included 6-in. and 8-in. single-speed desk and bracket fans, 8-in. and 10-in. three-speed desk and bracket fans, 8-in. and 10-in. oscillating three-speed fans, and an 8-in. Colonial base, three-speed nickel-finish, desk and bracket fan. The oscillating fans are also adjustable for desk or bracket mounting and they may be run non-oscillating, if desired.

Pittsburgh 8-in. Three-Speed Desk and Bracket Fan.



Pittsburgh 8-in. Oscillating Fan.

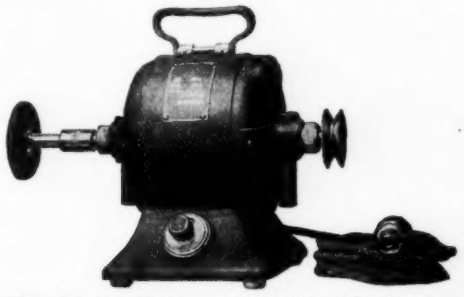
Westinghouse Polishing and Grinding Motors.

Polishing and grinding by means of an electric motor is no longer novel but it is the most practical and the quickest method of accomplishing the tedious labor formerly done by hand. With the new polishing and grinding motor placed on the market by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., it is possible to simply snap the switch starting the motor, and put a brilliant luster on silver pieces or a keen edge on cutlery in a few moments. The motor is always ready and needs only to be connected to any electric outlet for use.

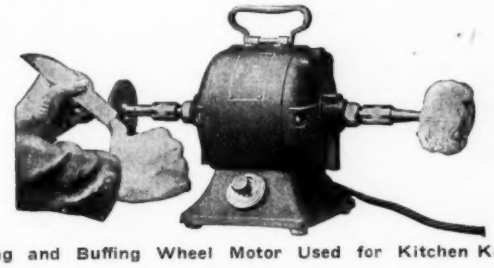
In the home, besides polishing silverware, brass, glassware, etc., and grinding the kitchen knives, the motor can be used for light power work in the work shop. By slipping a pulley on the motor shaft it can be used to drive small saws, lathes, drills, etc. It will operate all kinds of boys' mechanical toys with safety. For jewelers, the motor is of special advantage. With it their wares can be quickly given a luster which would require many times longer if done by hand. The motor is portable so that it can be carried from place to place as desired for convenience. For opticians and dentists the attachments enable many operations to be performed with the motor with advantage. The various chucks, wheels, drills, and pulleys adapt the motor for grinding, polishing, drilling, etc. Small air pumps and small lathes can be driven by means of a pulley. Ritter chucks can be used with the motor if desired. In the factory and repair shop the grinding motor is ideal for grinding small parts. Burnishing and polishing of small parts can also be done.

Among features of the motor are the following: It is simple, powerful, quiet and portable. It has an attractive glossy black finish. The single speed provided eliminates the complications of multi-speed motors and results in a simpler, more rigid and less expensive motor. Nickel handle is provided for carrying. The motor is totally enclosed. It has extra long dustproof bearings. The end play is negligible. Nickel bearing caps are provided to facilitate removal of chucks. A well designed, broad and substantial base provides stable mounting for the outfit. Rubber cushions or bumpers in base permit mounting motor on any surface without marring. There are holes in the base for fastening down, if desired.

Direct-Current Motor With Grinding and Buffing Wheels.



Alternating-Current Motor with Grinding Wheel and Pulley.



Grinding and Buffing Wheel Motor Used for Kitchen Knives.

Trade Activities

Isko Co. Moves Plant to Chicago—Ilg Ventilating to Erect Factory Buildings on Newly Acquired Property—Catalogs

Frank DePoy, formerly connected with the power plant at Greenfield, Ohio, and **S. H. Hart** have formed a partnership in the electrical repairing business and will do all kinds of work in the electrical line, wiring, etc., and also carry a complete line of electrical goods and supplies. Mr. DePoy, who was recently engaged in Government work in wiring ships, is a specialist with motors.

The Isko Co., Detroit, Mich., manufacturer of electrically-operated household and other refrigerating machines, has decided to move its entire plant to Chicago. The company has just closed a lease for two upper floors of a large new building erected by the Northwestern Terra Cotta Co. at the corner of Terra Cotta place and Clybourne avenue. These two floors contain an area of about 60,000 sq. ft. The growth of the company's business has been such as to require increased facilities and the new plant will give it a more central location so as to better serve the entire country.

Mohawk Electrical Supply Co., Syracuse, N. Y., is distributing a very attractive and unique calendar for the year 1919. It varies from the usual style of calendar in that the dates for the coming year are shown in large figures on a daily date pad, which may be readily seen at a distance. This pad, 4¼ by 5 in., is securely bolted to a heavy cardboard mounting, 8 by 22 in. in size, on which the building occupied by the company is reproduced in colors, ever bringing this progressive company to the mind of the user.

Ilg Ventilating Co., Chicago, manufacturer of electrically-driven ventilating fans and blowers, has purchased a large tract of land of an area of 325 x 1333 ft. at the corner of Crawford avenue and George street, where it is proposed to build a group of new factory buildings to house the very rapid growing needs of the firm. The company's plant is now located on Whiting street and has within recent years been enlarged several times, but the facilities there being inadequate it was decided to move to the outlying portions of the city. A large tract of land was purchased on Elston avenue last year but on finding that it was not so well situated as the one that has just been purchased, the latter site was acquired. It is proposed to erect the first unit of the new plant in the form of a three-story building to cost about $250,000. Additional units will be added, as the requirements necessitate so that eventually the entire business will be located at the new site, which has very good railroad connections, and is in a district where a workman can find good housing accommodations.

E. N. Haig, factory representative of the **Manhattan Electrical Supply Co., Inc.,** formerly at San Francisco, is now located at 1629 Harvard avenue, Seattle.

Edison Storage Battery Co. announces the removal of its New York sales office from 209 West 76th street to 247-251 West 35th street, New York City. The new location provides larger and more commodious quarters and will enable the company to serve the trade even better than in the past.

Coppus Engineering & Equipment Co., Worcester, Mass., has prepared a new catalog covering the Type CCC Coppus centrifugal turbo boiler feed pump, which is a distinct step forward in boiler feed pump engineering. This booklet describes in a very clear and interesting manner the many advantages of this pump, which are so distinct and definite that every engineer will appreciate their value.

Roller-Smith Co., 233 Broadway, New York City, announces the appointment of Frank R. Ryan to the sales force of its Chicago office located at 740 Monadnock Block. Mr. Ryan was graduated from the electrical engineering course of Notre Dame University, and spent over a year in the testing department of the Commonwealth Edison Co. and about the same time in the testing and operating department of the Sanitary District of Chicago. He was subsequently connected with The Krehbiel Co., consulting engineer, of Chicago, and for the past six months has been in the Signal Corps. Mr. Ryan assumes the position which was held by Chas. H. Nicholson before the latter entered the service and subsequently took charge of the company's Detroit office.

Heine Safety Boiler Co., St. Louis, Mo., is distributing to the trade the latest edition of its "Boiler Logic," an 80-page treatise on steam boilers. This treatise covers the following topics: Some fundamental considerations of boiler design, (a) furnace design requirements, mixing, time, temperature, (b) heat transmission from fire by radiation, (c) heat transmission by convection, (d) heat transmission through tubes and to water; practical baffling of water tube boilers, (a) flexibility of design, (b) leakage and cost of repairs and renewals, (c) active and inactive surface, (d) ease of cleaning soot and ash deposits; Heine boilers for different fuels, firing and services, hand firing with bituminous coal, hand firing with anthracite coal, chain grate stokers, underfeed stokers, oil fired, shavings and refuse, bagasse, gas fired, waste-heat boilers, dredge boat boilers, overloads; the boiler as a pressure vessel; and details of construction of Heine boilers.

Walter A. Zelnicker Supply Co., St. Louis, Mo., is sending to the trade a 16-page booklet (Bulletin 259) listing new and used tanks. The bulletin briefly describes many types and sizes of field, storage, pressure, glass-enameled lined tanks and tank accessories.

The A. & A. Electric Co., Waukegan, Ill., has been organized to engage in electrical contracting and will be located at 303 Washington street. The members of the firm are R. W. Ames and Edward Ahlstrom, both of whom are former employes of the Public Service Co. of Northern Illinois.

Cutler-Hammer Manufacturing Co., Milwaukee, Wis., is distributing a new and very pleasing 64-page catalog entitled "C-H Wiring Devices—Push Button Specialties." The appearance and contents indicate that much time and care were taken in the preparation of this book and that practically all of the wiring devices and push button specialties made by this company are illustrated, described and listed. The first 16 pages are devoted to a general description and listing of push sockets. The next quarter of the catalog is devoted to switches comprising candelabra, canopy, pendent, door and door-bolt, surface, pull, toggle-handle and appliance switches, and also the C-H feed through switches. Notably among the latter is the nationally advertised C-H seventy-fifty switch, the application of which with household and industrial appliances, are illustrated. The contractor dealer and large user of conduit fittings will find the center spread extremely useful. It is devoted to a complete table which lists the conduit fittings made by eleven different manufacturers, and gives the form and catalog number of the various fittings that may be readily used for mounting C-H receptacles and sockets. Another section illustrates and lists the C-H "Standard" interchangeable plugs and receptacles and the Rock-Off type of plugs and receptacles. A section at the end is devoted exclusively to the well-known C-H automobile lighting switches. These are shown singly and in groups of two to four and arranged for mounting either parallel or in tandem. Wiring diagrams are furnished to illustrate the use of these switches with the various methods of controlling automobile lighting and ignition. Among the other devices included, reference is made to remote control switches, vacuum cleaner control, etc., and to finish and other details. The book is well indexed and bound in striking orange buff-colored cover. It is intended for distribution to jobbers, dealers, contractors, central stations, architects, and others interested.

Current News

Weekly Record of Construction Activities—Conventions

EASTERN STATES.

Dana, Mass.—Arrangements have been completed by the Town Council with the Gardner Electric Light Co. for supplying electric energy for municipal purposes for a period of five years.

Fall River, Mass.—Plans are under consideration by the city for the construction of a municipal pumping station and dam, estimated to cost $150,000. James H. Kay is mayor.

Holden, Mass.—The Town Council is considering plans for the installation of a new fire alarm signal system.

Leominster, Mass.—Plans are under consideration by the city for the establishment of a municipal lighting system. It is undecided at the present time as to whether the plans call for the leasing or construction of a plant.

Marlboro, Mass.—Marlboro Electric Co. has had plans prepared for the construction of a transmission line between its Marlboro station and the generating station at the Metropolitan reservoir, Fayville. Robert Johnson is manager.

Worcester, Mass.—The city is having plans prepared for the construction of a brick and concrete laboratory and boiler plant on Salem street.

Providence, R. I.—Revere Rubber Co., Valley and Hemlock streets, has taken bids for the construction of the proposed one-story brick power plant at its works, about 50 x 90 ft. Lockwood, Greene & Co., Boston, Mass., are engineers for the company.

New London, Conn.—Bureau of Yards and Docks, Navy Department, has awarded a contract to the Carroll Electric Co., 712 12th street, N. W., Washington, D. C., for the installation of a new high pressure air system at the local naval station.

Buffalo, N. Y.—The city, through Arthur W. Kreinheder, Commissioner of Public Works, is arranging plans for various municipal work during the present year, including the completion of the large new power station on Porter avenue.

Jamestown, N. Y.—Jamestown Electric Co., 109 East Third street, has been awarded a contract for the installation of new lighting fixtures and other electrical work in connection with improvements at the State Armory, Jamestown.

Callicoon, N. Y.—Sullivan Electric Co. is planning an electric power plant at Delaware, N. Y. Application has been made to the Public Service Commission.

New York, N. Y.—Mitchell-Rand Manufacturing Co., manufacturer of electrical insulations, etc., has leased property in the building at 18 Vesey street, to provide for increased operations.

New York, N. Y.—In connection with the construction of the New Commodore and Pennsylvania Hotels, opened to the public during January, a total of 26 passenger elevators and 23 freight and service elevators were installed, 1,200,000 ft. of conduit and 3,250,000 ft. of wire was used. The structures were erected by the George A. Fuller Co., New York, and are the two largest buildings of their kind in the world.

New York, N. Y.—In connection with the construction of a new factory addition at its plant at 217 Riverdale avenue, Yonkers, contract for electrical work has been awarded to J. G. Metzger, 91 Broadway, Newburgh.

Niagara Falls, N. Y.—Union Carbide Co., Union street, has awarded a contract to the J. F. McKinney Co., Union street, for the construction of a two-story brick, concrete and steel electric switching station, about 53 x 139 ft. The new structure is estimated to cost $45,000.

Rockaway, N. Y.—Fire on Jan. 31 damaged a portion of the power plant at the local Naval Air Station. Two airplane hangars at the station were completely destroyed. It is understood that the Government is planning for immediate repairs.

Sangerfield, N. Y.—Waterville Gas & Electric Co. has recently made application to the Public Service Commission for permission to construct and operate a local electric plant.

Seneca Falls, N. Y.—Announcement has been made by the Seneca Falls Water Co. that the proposed new pumping equipment to be installed in its station at Bridgeport, on order since April of last year, but held up due to the war, has been delivered, and work will commence at once on the installation.

Springwater, N. Y.—Springwater Electric Light Co., Inc., has petitioned the New York State Public Service Commission, Albany, N. Y., for permission to construct an electric plant in Springwater.

Waterville, N. Y.—Waterville Gas & Electric Co. has petitioned the New York Public Service Commission, Albany, N. Y., for permission to construct an electric plant (extension) in the town of Sangerfield, N. Y., and for the approval of franchise.

East Orange, N. J.—The City Council is considering plans for the installation of a new electric street-lighting system on Central avenue and Main street. Service will be furnished by the Public Service Corporation. Louis C. Geils is chairman of the lighting committee.

Kearny, N. J.—Plans are being prepared by Swift & Co., 32 10th avenue, New York, for the rebuilding of its fertilizer and glue plant on Harrison avenue, Kearny, including boiler plant, recently destroyed by fire, with loss estimated at $150,000.

Keyport, N. J.—Monmouth Lighting Co. is making rapid progress in the construction of an addition to its power plant on Florence avenue, Raritan Township. Immediately upon completion of the structure it is proposed to install a new 556-hp. capacity boiler with auxiliary apparatus, to provide for increased operations.

Newark, N. J.—Hillside Township Committee is arranging plans for the installation of new street-lighting systems on Fairbank, James, Bond, Clark and Virginia streets, and Coe, Roanoke and Ridgway avenues.

New Brunswick, N. J.—Considerable new electrical equipment for operation will be required by the Board of Freeholders in connection with the construction of the new Albany street draw bridge, estimated to cost $128,575.

Paterson, N. J.—In connection with the construction of the proposed school buildings by the Board of Education, to be known as Nos. 6 and 7, and located at 389-405 Broadway, and at Dixon, Ramsey and Caldwell avenues respectively, considerable new electrical equipment will be required.

Trenton, N. J.—The city is arranging plans for the installation of new pumping equipment at the Riverside Heights and Fair street sewerage pumping station.

Union Hill, N. J.—Notice of authorization has been filed by the Union Electric Co. to operate at Kossuth street and Palisade avenue for the production of electrical specialties. J. Schmidlin, 301 Kossuth street, heads the company.

Verona, N. J.—Runyon & Carey, 845 Broad street, Newark, have been retained by the Board of Chosen Freeholders of Essex county as consulting engineers for heating, ventilating and electrical work in connection with the proposed construction of a group of five one-story hospital buildings at the local Hospital for Tubercular Diseases, estimated to cost $120,000.

Hawley, Pa.—Welewood Silk Mills has plans under consideration for the construction of a hydroelectric power plant for works operation. W. F. Suydam is manager.

Honesdale, Pa.—Honesdale Consolidated Heat, Light & Power Co. is considering the construction of a one-story brick power plant, estimated to cost $50,000, to replace the plant recently destroyed by fire.

Mt. Carmel, Pa.—The Susquehanna Collieries Co. has completed plans for electrification of its anthracite operations in the Mount Carmel and Shamokin coal field. It is proposed to erect one central power plant to cost $2,000,000 at Green Ridge, near the Pennsylvania Colliery, with high voltage transmission lines to the Richards, Pennsylvania, Scott, Hickory Ridge, Luke Fidler and Cameron collieries. At all of these operations electrically-driven machinery will supplant that now used in slopes, planes and breakers. Besides supplying power to drive the outside machinery wires will be strung in the mines for the underground operations, which include drilling equipment, electric locomotives and lighting.

Palmerton, Pa.—New Jersey Zinc Co., 45 Wall street, New York, is considering plans for the construction of a local one-story brick heating plant, about 30x40 ft. in size, to be located at the south end of Fourth street.

Philadelphia, Pa.—The Philadelphia General Hospital has had plans prepared for the construction of a three-story brick tower at 34th and Pine streets, and the installation of two electrically-operated elevators.

Philadelphia, Pa.—The City Bureau of Water is planning for the erection of a fireproof building to replace the structure at present housing the new $80,000,000 turbo-centrifugal pumping unit recently placed in operation at the Lardner's Point station.

State College, Pa.—The Board of Trustees of the Pennsylvania State College has authorized the expenditure of $150,000, to provide for the construction of a large power plant at the institution located at State College.

Norfolk, Va.—Navy Department, Washington, D. C., has let contract to R. R. Richardson, Bank of Commerce building, Norfolk, at $48,950, to erect two radio buildings.

Charleston, W. Va.—Fryland Coal Co. has organized and will expend $50,000 for building plant in Kanawha county. Two drift mines will be opened and electrical machinery installed. Address C. G. Rowland, president, Nitro.

Shelby, N. C.—Double Shoals Cotton Mills are considering plans for the construction of an electric light system to furnish service to the mill village.

Charleston, S. C.—Charleston Consolidated Railway, Gas & Electric Co. will hold a special meeting on March 19 for the purpose of voting on an increase in the common stock of $1,500,000, to provide, in part, for proposed extensions and improvements. Work is under way on the enlargement of the electric power house of the company, and the completion of a transmission system to Port Terminal, North Charleston.

Sumter, S. C.—The establishment of municipal electric light plant is contemplated. Address mayor.

Atlanta, Ga.—The city is considering plans for the construction of a generating plant at the local crematory. It is understood that a meeting has been called for March 5, to vote on a bond issue for $300,000 to provide for the proposed construction.

Brunswick, Ga.—Mutual Light & Water Co. contemplates improving electric light plant.

Cordele, Ga.—An election may be held upon issuance of municipal bonds for establishing electric light plant.

Starke, Fla.—The city is considering plans for a bond issue, a portion of the proceeds to be used for improvements in the municipal power plant.

DATES AHEAD.

New Mexico Electrical Association. Annual meeting, Albuquerque, N. Mex., Feb. 17-19. Secretary-treasurer, Charles E. Twogood, Albuquerque, N. Mex.

American Institute of Electrical Engineers. Annual mid-winter convention, Engineering Societies building, New York City, Feb. 19-21. Secretary F. L. Hutchinson, 33 West 39th street, New York City.

Society of Industrial Engineers. National conference, New York City, March 18-21. Secretary, Irving A. Berndt, 327 South La Salle street, Chicago, Ill.

Wisconsin State Association of Electrical Contractors and Dealers. Annual convention, Hotel Pfister, Milwaukee, Wis., March 24-28. State secretary, John A. Piepkorn, 108 Sycamore street, Milwaukee, Wis.

Wisconsin Electrical Association. Annual meeting, Milwaukee, March 25-27. Secretary, J. P. Pulliam, 1408 First National Bank building, Milwaukee.

Tri-State Water and Light Association. Annual meeting, Greenwood, S. C., April. Secretary-treasurer, W. F. Steiglitz, Columbia, S. C.

National Fire Protection Association. Annual meeting, Ottawa, Ont., May 6-8. Secretary-treasurer, Franklin H. Wentworth, 87 Milk street, Boston, Mass.

American Society of Mechanical Engineers. Spring meeting, Hotel Statler, Detroit, Mich., June 17-20. Secretary, Calvin W. Rice, 29 West 39th street, New York City.

Ohio Electric Light Association. Annual meeting, Cedar Point, Ohio, July 15-18. Headquarters, Breakers Hotel. Secretary, D. L. Gaskill, Greenville, Ohio.

Association of Iron and Steel Electrical Engineers. Annual convention, St. Louis, Mo., September, 1919. Secretary, John F. Kelly, Empire building, Pittsburgh, Pa.

NORTH CENTRAL STATES.

New Philadelphia, Ohio.—The council is considering the advisability of erecting a municipal light and power plant. Discussion was provoked by dissatisfaction with the service of the Ohio Service Co. that the existing franchise and street lighting contracts between the city of New Philadelphia and the Ohio Service Co. be carefully gone into and recommendations made at the next council meeting. The examination of the franchise and contract will be made by city solicitor P. S. Olmstead.

Oxford, Ohio.—The village council has decided to abandon the municipal electric light plant. Current will be purchased from Richmond, Ind. It is estimated by engineers that this arrangement will effect a saving of $5,400 a year. The electrification of the water works plant will follow shortly, giving another saving to the town of $4,800 a year.

Anderson, Ind.—The Indiana Public Service Commission has granted the city of Anderson permission to issue $90,000 worth of bonds to apply on improvements on the municipal light and water plant, and also for an immediate temporary loan of $46,265 with which to make the first payment on material now being delivered. Paul P. Haynes, of the commission, ascertained that the extent of the bond issue had been included in the annual budget, thereby leaving the city of Anderson within 2% of the limit of bonded indebtedness. A petition for an inventory of the municipal light and water plants to determine their physical valuation was granted. The water department is out of debt and is making a fair profit but the light department has an indebtedness of $65,000 and further extension of the light plant to provide electric power for industries are proposed.

Auburn, Ind.—The City Council will open bids Feb. 17 for the installation of an air compressor, reservoir and air lift pumps in the Auburn water and electric light plant. Bids will be opened for the purchase of $7,500 in city bonds, which it is believed will cover the expense of installing the above equipment. Address Glenn Polks, city clerk.

Elkhart, Ind.—The board of education is selling a bond issue of $120,000, the proceeds to be used for the erection of a new school building.

Evansville, Ind.—E. E. Brownell, consulting electrical engineer, of Philadelphia, has been retained by the waterworks board to make an electrolytic survey of the water system of the city. Charles Streithof, superintendent.

Fort Wayne, Ind.—Remy Electric Co. has been made a part of the General Motors Co. For the past five years it had been a part of the United Motors Corporation. No changes in the personnel of the Fort Wayne are contemplated, according to E. F. Creager, plant manager.

Hammond, Ind.—Standard Oil Co. will equip its 21,000-hp. plant at its Whiting refinery with a full load capacity of 40,000 hp. The company is also erecting a new coal bunker 200 ft. wide, 1000 ft. long and 25 ft. deep with capacity of more than 125,000 tons. Additional stills, six stanchite, 14 reducing and six korite and a number of pressure stills are being planned. The new refrigerating plant will have capacity of more than 400 tons daily. Other anticipated improvements include a large storehouse and a deep sewer to the canal.

Logansport, Ind.—A resolution appropriating $5000 out of the electric light fund with which to purchase a carload of electric light poles and 23,100 ft. of copper wire was unanimously approved by the council. The equipment is to be used in building the electric line from the plant to the new Pennsylvania shops.

Mishawaka, Ind.—The Indiana Public Service Commission has held illegal a charge of $1 a hp. for electric power current which was to have

been established by the city of Mishawaka.

Muncie, Ind.—Fire destroyed the four-story Stillwell department store with loss of $200,000.

Noblesville, Ind.—Noblesville Heat, Light & Power Co. has received permission from the Indiana Public Service Commission to continue in effect a surcharge authorized by the commission last year and dated to expire Sept. 1. One-half cent a kw-h. is the added charge.

Shelbyville, Ind.—Attorneys for the Interstate Public Service Co., owners of the electric power plants in Franklin and Shelbyville, have filed a petition before the board of commissioners of Shelby county asking permission to string electric wires which will reach from Franklin to Shelbyville. It is the intention of the company to open a transmission line in order that power may be furnished in either city from either plant.

Spencer, Ind.—The Indiana Public Service Commission has denied the petition of the Spencer Light, Power, Heat & Water Co. for a rehearing of a petition for increased electric rates. Some time ago the Commission rejected the petition because it was found the company is earning enough revenue for the amount of money invested in the plant.

Vincennes, Ind.—Indiana Power & Water Co. will expend approximately $150,000 for improvements. The company plans to supply power and light to the Illinois oil fields to the west of Vincennes by stringing three 33,000-volt wires across the Wabash river, spanning the stream. The power will be sold to the Central Illinois Public Service Co.

Chicago, Ill.—Krasberg Manufacturing Co. will erect a seven-story building, approximately 109x200 ft., on ground recently purchased. The total cost of ground and building will aggregate $300,000.

Decatur, Ill.—A subway under the Wabash tracks at Seventh street is being considered by the Illinois Public Utilities Commission. The subway will cost from $300,000 to $500,000, will be from 1,700 to 1,800 ft. long and will have 14 ft. head room, two driveways each 14 ft. wide and two sidewalks each 5 ft. wide.

Decatur, Ill.—Comet Automobile Co. will install a $35,000 power and heating plant.

Elgin, Ill.—The Illinois Public Utilities Commission has authorized the South Elgin Electric Light Co. to discontinue the operation of its plant. This power plant was established 16 years ago and suspended business Nov. 7, 1918, because the machinery of the plant has become antiquated and the cost of replacement would render the operation of the plant prohibitive. South Elgin was left without electric light service until a short time ago when 12 street lamps were installed by the Aurura, Elgin & Chicago Railroad Co.

Galesburg, Ill.—Galesburg Railway, Lighting & Power Co., a subsidiary of the Illinois Traction System, is installing a giant fly-wheel, 18 ft. in diameter, with 22-in. face at the Weinberg power plant.

Monticello, Ill.—Syrup Pepsin Co. will erect a new concrete and steel $100,000 building, 150x60 ft., four stories in height. The plans were drawn by J. C. Llewelyn of Chicago and W. F. Lodge of Monticello was awarded the contract.

Pekin, Ill.—A remarkable record was made by the Pekin Municipal Railway for the month of January. The receipts totalled $2,460.20 and as the line extends only two and one-half miles and operates only on two principal streets, the average for the 31 days was $79.36.

Woodstock, Ill.—The question of issuing $25,000 light and power bonds will be submitted to vote. S. E. Olmstead, mayor.

Beaver Dam, Wis.—The city council is considering changing arc lamps in use for 60-cp. nitrogen-filled lamps.

Beloit, Wis.—Plans are under consideration for extension of ornamental lighting system. Address Engineer Arthur Sweet, Palace building, Milwaukee.

Janesville, Wis.—Engineer J. C. Jacobson, 1135 First National—Soo Line building, Minneapolis, Minn., will prepare plans for an electric power plant to be established by the city.

Minocqua, Wis.—A special election will be held to vote on the question of issuing bonds for the purchase of Minocqua plant and supply city with electricity from Rhinelander. T. A. Forbes, president of the Rhinelander Light & Power Co.

New Ulm, Minn.—The city contemplates building an addition to electric light and water plants. A. J. Mueller, city superintendent.

Willmar, Minn.—Resolution is before the council recommending the purchase of engine and electric generator be installed in water and light plant. Hans Gunderson, city clerk.

Davenport, Iowa.—C. E. Schlegel, representing the Davenport Retail Merchants' Bureau, has asked the city council to take over and maintain the electric lights or electroliers in the business district. Practically all of the electroliers in the business district are being maintained by the merchants.

Monticello, Iowa.—Monticello Electric Light Co. is planning to extend its service into the surrounding towns. Sand Creek will be one town which will be added to the service of the company.

Butler, Mo.—J. F. Kern is interested in the proposed establishment of electric light plant to furnish 25 electric lights.

Kansas City, Mo.—Two-thirds of the persons owning property on Central avenue, Kansas City, Kans., have petitioned the mayor and the city commissioners for clusters of ornamental lights along Central avenue from Seventh street to 23rd street. L. H. Chapman, water and light commissioner, said that the lights were needed and work will be started in the spring.

Kansas City, Mo.—Kansas City Light & Power Co., 1500 Grand avenue, will erect an electric substation at 31st street and Robert Gillham Road. Address R. J. Clark, general manager.

St. Joseph, Mo.—Morris & Co. will build a two-story, brick and concrete addition to its box factory, to cost $45,000.

Beatrice, Neb.—The Beatrice lighting plant has under consideration the erection of an electric light plant at Plymouth. B. H. Conlee is manager.

SOUTH CENTRAL STATES.

Montgomery, Ala. — Montgomery Light & Traction Co. will make improvements and extensions. Address Ray Rushton, receiver.

Benton, Ark.—G. A. Smith, superintendent of the water plant, has acquired the electric plant. An engine and 125-kw. generator for the water plant will be installed, and repairs and renewals made on the distribution system.

Alva, Okla.—Following a general conference between local business men and officers of the Southwestern Utilities Co., promise is given that material improvement will be made in the electric light and power service in Alva.

Mount Auburn, Tex.—The citizens of Mount Auburn and Parkview additions voted to establish a street car system of their own. Officers were elected and a plan introduced to raise $125,000 for the purpose of building an electric line that would serve the needs of the residents of both districts as well as that part of Dallas located east of the State Fair Grounds. Address Henry G. Wills.

WESTERN STATES.

Cook City, Mont.—Western Smelter & Power Co., operating mine, smelter and power plant at Cook City, plans to install a 100-hp. motor to drive an air compressor at its mine and to install additional transformers at its hydroelectric plant with which to step up voltage to 23,000 for transmission to other mines in the district. G. L. Tanzer is president of the company.

Lamar, Colo.—A request has been filed by representatives of the town with the state public utilities commission for permission to erect a municipal light plant.

Lewiston, Idaho.—Plans for the development of electrical power from the Salmon river, 35 miles from this place, have been outlined by F. S. Rice, mining engineer, who secured the rights at Horseshoe Bend in the Salmon river, and has obtained the government right to tunnel through the bend and construct a dam to divert the flow of the river. According to Mr. Rice, sufficient power to operate a government nitrate plant could be developed by the project.

Everett, Wash.—This city will vote in the near future on the question of establishing a light and power plant. City commission has been working for several months on a plan for developing power on the Sultan river. The development would call for 6000 hp.

Olympia, Wash.—Looking to the eventuality of the purchase of the Rainier Valley street car system by Seattle, a bill has been introduced in the state legislature of Washington amending Chapter 59 of the state laws of 1917, giving cities the right to acquire and maintain street railways that extend beyond the corporate limits within a five-mile limit.

Pilot Rock, Wash.—The city has secured a plot of ground 50x80 ft. for the erection of a light plant.

Seattle, Wash.—Claiming that the development of the Skagit power project will require many years, Fred W. Kelly has suggested that the city make use of the Swan Lake storage reservoir as a means of securing additional electric energy quickly. This reservoir, as a part of a system of extensions will store a three months' supply of water. Mr. Kelly states that this impounded water can be used by the city to generate electricity.

Yakima, Wash.—Development of power on the Wapato project is included in the plans of the United States Indian Service now working on four drops on the reservation intended to develop approximately 10,000 hp. Power will be available from these sources only during the irrigation season.

Astoria, Ore.—The port of Astoria has authorized the sale of additional bonds totaling $750,000. The money is to be used in proposed extensions during the coming year. Among the improvements contemplated is an export and import pier and warehouse; additional power plant for the industrial growth of the city, etc.

Portland, Ore.—Bids have been called by the Commission of Public Docks for furnishing materials and wiring for Pier 1, St. Johns Terminal, for light and power and a roadway leading to Pier 1 for light.

Eureka, Cal.—Western States Gas & Electric Co. is making rapid progress in the construction of extensions in its system for the purpose of furnishing electric power to the Humboldt Transit Co.

Los Angeles, Cal.—The city commission has had plans prepared for the construction of a power transmission line for supplying electric energy to the municipal pumping plant in the Elendale district. The work is estimated to cost about $4,100.

Madera, Cal.—San Joaquin Light & Power Co. has had plans prepared for the construction of a new substation and power lines for furnishing electric energy in the Chowchilla district. It is understood that the transmission line will be of 60,000-volt capacity, with plant located on the Robertson boulevard about five miles from Chowchilla.

San Francisco, Cal.—Plans are under consideration by the Sierra & San Francisco Power Co. for the erection of two new substations, one at Brentwood and the other at Byron in connection with the rebuilding of its distributing systems at these locations. C. S. Northcutt, Modesto, is district manager.

San Jose, Cal.—S. G. Winch has awarded a contract to W. D. Baker, Porterville, for the installation of a new electrically-operated pumping plant at Plano.

INCORPORATIONS

Indianapolis, Ind.—Federal Electric Co., to deal in general electrical supplies, has been incorporated by H. J. Dunbaugh, John E. Wing and Cyrus H. Adams, Jr.

Columbus, Ind.—Cummins Engine Co. has been incorporated with capital of $50,000 to manufacture and sell combustion engines. The directors are C. L. Cummins, E. D. Snider, J. R. Dunlap, John E. Northway and Frank N. Richman.

Terre Haute, Ind.—Baines Electric Service Co. has been incorporated with $5000 capital. The new company will deal in electrical equipment and will do electrical contracting. The directors include C. C. Baines, Joseph F. Bruner and G. W. Baines.

Brooklyn, N. Y.—Cassidy Co., Inc. Capital, $250,000. To engage in the manufacture of gas and electric light fixtures, etc. Incorporators: G. W. Cassidy, W. N. Baylis and A. Wahle, 1492 Bushwick avenue.

New York, N. Y.—Maxim Electrical Corporation. Capital, $25,000. To manufacture electrical apparatus, etc. Incorporators: S. M. Knopf, F. F. Butner and J. Harris, 1457 Broadway.

Brooklyn, N. Y.—Ferro Electric Welding Co. Capital, $150,000. To operate an electrical contracting establishment. Incorporators: K. Furubotn, A. Meyer, and O. Johannessen, 95 E. 18th street.

Newark, N. J.—Walmax Manufacturing Co. Capital, $125,000. To engage in a general electrical specialty manufacturing. Incorporators: M. and M. Walther, and O. Ventsch, Newark.

PROPOSALS

Boiler.—Bids will be received by the Superintendent of Lighting Plant, LeSueur, Minn., until 8 p. m., Feb. 21, for installing one 150-hp., 150,000-lb. pressure tubular boiler.

Air Compressor.—The City Council of Auburn, Ind., will open bids Feb. 17 for the installation of an air compressor, reservoir and air lift pumps in the Auburn water and electric light plant. Address Glenn Polks, city clerk.

Power Plant Equipment.—Bids will be received Feb. 17 for installing machinery equipment and piping in power plant at Hampton Roads, Va. (Specification No. 3328), by the Bureau of Yards and Docks, Navy Department, Washington, D. C.

Wire and Cable, Switches, Pumps, Etc.—A. L. Flint, general purchasing agent, Panama Canal, Washington, D. C., will receive bids until 10:30 a. m., Feb. 19, for furnishing wire and cable, pumps, valves, electric switches, cable grips, etc.

Pumps.—Bids will be received until 3 p. m., March 7, at Pembroke, Ont., for installing one water works pumping unit, comprising turbine pump of 2,000-gal. capacity against 330 ft. head, and steam turbine or gasoline engine direct connected to pump. W. J. Moore, town engineer.

Electric Wiring, Lighting, Power and Battery-Charging Equipment.—Bids will be received by W. W. Wotherspoon, superintendent of public works, Capitol, Albany, N. Y., for improvement of state canals, involving protecting the shore of a part of Erie Basin; installing electric wiring, lighting, power and battery-charging equipment for canal terminal at Buffalo.

Power Plant Equipment.—Bids will be received until 10 a. m., Feb. 26, by the Henningson Engineering Co., Omaha, Neb., for rebuilding the municipal light and power plant, at Julesburg, Ohio, including one 250-kv-a., alternating current generator direct connected to steam engine; two 250-hp. water-tube boilers; auxiliary steam equipment; switchboard equipment; concrete or brick chimney; pole line material; centrifugal pump, etc.

Electrical and Lighting Materials.—Bids will be opened by the Treasury Department, Supervising Architect's Office, Washington, D. C., at 3 p. m., March 3, for furnishing the electrical and lighting materials for the Hospital Unit A-Special, Hospital Unit B-1, the attendants' quarters, additions to and changes in the kitchen and mess hall, and for outside services, at the United States Marine Hospital, Baltimore, Md., in accordance with the specifications and bills of quantities attached thereto.

Fuses, Etc.—Sealed proposals will be received Feb. 18, at Room 406 City Hall, Chicago, to furnish and deliver to the City of Chicago at the Municipal Warehouse, 3150 South Sacramento avenue, all renewable inclosed electric fuses, repair parts and appurtenances required during the term ending Dec. 31, 1919, according to specifications on file in the office of the Department of Public Works of said city, Room 406 City Hall. Address Chas. R. Francis, Commissioner of Public Works.

Electrical Material and Lighting Supplies.—Bureau of Supplies and Accounts, Navy Department, is receiving bids for the following material: 28 watertight annunciators for delivery at Puget Sound navy yard (Schedule 3724); lighting and power cable, 250 lb. annunciator wire, for delivery at Mare Island; 90,000 ft. ship-lighting cable and telephone wire, for delivery at Boston and Mare Island; 2,000 ft. three-conductor cable and 36,000 ft. bridle, telephone wire to be delivered at Puget Sound; 10,000 ft. lead-sheathed cable and a miscellaneous quantity of rubber-covered wire, for delivery at Brooklyn; a miscellaneous quantity of telephone cable, for delivery at Boston (Schedule 3683); 27,000 ft. three-conductor cable for delivery at Brooklyn; two switchboards, high and low tension, six disconnecting switches and eight panels, for delivery at Alexandria, Va. (Schedule 3667); fuse and fuse elements and enclosed fuses, to be delivered at various shipyards (Schedule 3646).

Personal

J. C. Damon Returns to West Penn Power—C. M. Lindsay Promoted—W. E. Coman Joins Washington Water Power

F. A. HAZZARD, Allentown, Pa., secretary and treasurer of the Easton Transit Co, Easton, and affiliated companies, has resigned, effective March 1.

H. J. WOODWARD, until recently with the Economy Fuse & Manufacturing Co., Henry building, Seattle, has joined the Seattle forces of the Fobes Supply Co.

S. A. DRAKE has been elected president of the Illinois Central Electric Railway Co., Canton, Ill., to succeed Leslie W. Morton, lately deceased. W. T. Hanlon was chosen a director to succeed Mr. Morton.

HARRY J. HORNUNG, formerly connected with E. B. Latham & Co. and secretary of Fullerton Electric Co., is now associated with the Baily Electric Supply Co., New York City, as general manager and assistant treasurer.

CAPT. RAYMOND BURNHAM, who was affiliated with the Fairbanks-Morse Co. before entering the national service, has opened an office as a consulting and designing engineer at Room 935 McCormack building, Chicago.

F. E. GOODNOW, of the general office staff of the Public Service Co. of Northern Illinois, has become engineer of electrical design, succeeding H. F. Lempuhl, who recently resigned his position with the company to enter other business.

O. G. ENGSTROM, formerly line foreman in the Hutchinson section of the Southwestern Division of Northern States Power Co., has been appointed superintendent to succeed Thomas Pitts, who is now assistant to the manager at Montevideo.

R. L. BAKER, formerly manager of the used equipment department of the Railway & Mine Supply Co., of Chicago, has opened an office in the Edison building, 72 West Adams street, Chicago, where he will engage in the salvage of first-class power plants and usable steel and wood scrap. Mr. Baker has had a wide experience in engineering work which should prove of value to his clients in this undertaking.

GORDON E. VARNEY, president and founder of the Varney Electrical Supply Co., Indianapolis, Ind., has sold his interest in the concern to the other stockholders of the company. Before coming to Indianapolis, Mr. Varney was graduated from the School of Mines of Lafayette, Pa., where he was trained as a construction engineer. He later was in the service of the General Electric Co. Mr. Varney came to Indianapolis in 1893, and in 1896 opened a wholesale electrical house. After several years of successful operation he sold this business, and in April, 1900, he organized the Varney Electrical Supply Co., which has witnessed a steady growth since its inception.

CURTIS M. LINDSAY, for the past year sales manager of the Hotpoint Division of the Edison Electric Appliance Co., Inc., Chicago, has been promoted to the position of manager of the advertising and sales promotion department of the company, as briefly noted in the Jan. 18 issue of ELECTRICAL REVIEW. This new position was created to co-ordinate various departments, such as the advertising, co-operative, publicity and contract departments, with a view to establishing closer relations between the customer and the company, and the general advertising program, and for the purpose of building up the company's sales service with its customers to the highest possible degree. Mr. Lindsay is a graduate of the electrical engineering department of Armour Institute, class of 1909. After a period of engineering field work with the J. G. White Co., he joined the forces of the Hotpoint Electric Heating Co., Ontario, Cal., in 1912, becoming connected with the sales promotion department. Two years ago he came to Chicago as assistant to the eastern sales manager of the Hotpoint company, and for the past year has been sales manager of the Hotpoint Division of the Edison Electric Appliance Co. Mr. Lindsay has been identified with the Hotpoint sales and advertising campaigns since he started with the company, and his experience has eminently fitted him for his new position.

Curtis M. Lindsay.

S. C. BRATTON, who for the past eight years has served the Portland Gas & Coke Co., Portland, Ore., as commercial manager, has become manager of the commercial department of the Electric Bond & Share Co., New York City, which is banker and fiscal agent for the American Power & Light Co. and its many operating companies, among which are the Portland Gas & Coke Co. and the Pacific Power & Light Co.

B. H. KITTLE, who has been in the service of the Wabash Valley Electric Co., has taken charge of the office of the Kester Electric Co., Terre Haute, Ind.

C. O. MARTIN, who was recently discharged from the aviation department of the Government service, is representing the Benjamin Electric Manufacturing Co. of Chicago, at Seattle, Wash.

R. S. TORRENCE, who for some months has been general commercial agent for the Wisconsin-Minnesota Light & Power Co., has been appointed district manager of the company with headquarters at Eau Claire, Wis.

W. G. LORD, formerly chief electrician of the Arkansas Valley Railway Light & Power Co., Pueblo, Colo., has been appointed superintendent of the Pueblo division, succeeding C. A. Orr, resigned.

LESTER E. ARMSTRONG has accepted a position as advisory engineer with the Powdered Coal Engineering & Equipment Co. of Chicago. Prior to his service in the Air Branch of the Army, Mr. Armstrong was associated with Babcock & Wilcox Co.

A. TURNBULL, formerly connected with the heating device department of the General Electric Co., has been released from the aviation department of the service and is representing the Edison Electric Appliance Co. in the Northwest with headquarters at Portland.

W. JOCELYN DALE, superintendent of power for the Matahambre Copper Mines at Minas de Santa Lucia, Pinar del Rio, Cuba, has tendered his resignation to become connected with the Eli Sugar Co., as electrical engineer, and as engineer with the Cuba Can Sugar Corporation, Havana, Cuba.

FRANK E. MCINTYRE, general superintendent of the National Steel Foundries, the foundry division of the National Brake & Electric Co., Milwaukee, resigned from that position on Feb. 1 to become vice-president and general manager of the Hercules Steel Castings Co., Milwaukee, which began operations at its new plant recently.

W. RAWSON COLLIER, for a number of years sales manager of the Georgia Railway & Power Co., Atlanta, Ga., was recently appointed operating manager of the electrical department (including the steam heat department), both inside and outside of the seven-mile zone. Mr. Collier will be in charge of all operating matters in connection with and incident to the production, transmission and distribution of electrical energy and steam heat by the company. He will continue to act as sales manager of the company, in addition to his new duties.

PAUL EVANS GREEN, president of Marr, Green & Co., engineers, Chicago, has returned to the active management of the firm. Mr. Green, during the war, was engaged in Government service, supervising the design and construction of towns for the housing of munition workers.

E. B. HOOK, JR., who prior to enlisting in Government service was superintendent of high tension construction of the Georgia Railway & Power Co,. Atlanta, Ga., recently received his discharge and has returned to civilian life with Lockwood, Greene & Co., as a field engineer, with headquarters in Atlanta.

F. W. PENNOCK, who for the past 18 months has served the Imperial Munitions Board in the capacity of electrical engineer, has rejoined the R. E. Clegton Co., Montreal, Que., whose business was recently incorporated under the name of Cleaton Co. (Canada), Ltd., and will act as general manager of the concern.

ALFRED C. WILSON, engineer of the electrical department of the Georgia Railway & Power Co., Atlanta, Ga., has tendered his resignation to join the Southeastern division of Lockwood, Greene & Co., in the capacity of assistant electrical engineer. For more than fifteen years Mr. Wilson was connected with these companies, having first been employed with the company following his graduation from the Georgia School of Technology.

C. G. ADSIT, for several years advisory and consulting engineer of the executive department of the Georgia Railway & Light Co., Atlanta, Ga., has been appointed consulting engineeer for all departments of the company. Mr. Adsit has been closely identified with several big engineering tasks the company has undertaken since it entered upon the Tallulah Falls development work, and his achievements have contributed appreciably to his high standing among prominent electrical engineers of the country.

W. B. DEFOREST, a farm light specialist for the Kansas City branch of the Western Electric Co., with headquarters at Oklahoma City, has been appointed manager of the Kansas City office, succeeding H. L. Harper. Mr. DeForest has been in the employ of the company about 10 years, having joined the Kansas City house as a salesman in April, 1909. Three years later he was transferred to the St. Louis branch, but remained there only three months, returning to Kansas City as telephone sales manager. He continued in this work until April of last year, when he was made farm light specialist.

D. J. BUTTS, who has been manager for the Los Angeles branch of the Western Electric Co., since March, 1917, is now district sales specialist at San Francisco. Mr. Butts began his career with the company at Chicago in 1903, his first work being armature winding. In 1905 he went to Hawthorne and was engaged in engineering work there for a year. The following year he was sent to New York and in December of the same year was transferred to the sales department. He remained in New York until 1910, when he went to Boston, and in 1916 he was transferred to Salt Lake City as manager, where he remained until he became manager at Los Angeles.

H. L. WILLS, who has been connected with the Georgia Railway & Power Co., Atlanta, Ga., for a number of years, has been appointed engineer of the electrical department, both inside and outside of the seven-mile zone. Mr. Wills will be in charge of all engineering and construction, transmission and distribution of electrical energy by the company.

H. L. HARPER, who has been affiliated with the Kansas City branch of the Western Electric Co. for almost 15 years, has become manager of the Los Angeles house. Mr. Harper was first employed in the shipping department in 1903, and after working in the stock and credit departments was made a telephone salesman in December, 1907. Three years later he was placed in charge of the telephone sales and retained that position for more than two years.

W. E. COMAN, vice-president and general manager of the Northwestern Electric Co., Portland, Ore., has become vice-president and general manager of the Washington Water Power Co., Spokane, Wash., succeeding Harry L. Bleecker, deceased. Mr. Coman will assume his new duties about March 1. For many years Mr. Coman was associated with the traffic departments of the Great Northern, Spokane, Portland & Seattle and O. W. R. & N. roads. As general manager of the Northwestern Electric Co. he has had charge of the light and power system of the Portland company, both on the Oregon and Washington sides of the Columbia. Mr. Coman is a man of wide experience and is well known in the electrical industry.

MAJOR JOHN C. DAMON, Engineers, United States Army, who was taken from the 114th Regiment of Engineers for special duty in the Power Section of the War Industries Board, has now finished this work and returned to civil life, and entered the organization of the West Penn Power Co. Major Damon was born in 1882 in Concord, Mass., and was graduated from the Massachusetts Institute of Technology in 1905, remaining there the following year as assistant in the electrical engineering laboratory.

His professional experience began in the construction department of the Chicago Telephone Co., but he soon left this for construction work on large hydroelectric developments and transmission lines in the West. In 1909 he became superintendent of operation of the Colorado division of the Telluride Power Co., and in the following two years reconstructed and brought up to a high state of efficiency a large part of this pioneer electrical development. In 1911 he entered the organization of the Trinidad Electric Transmission Railway & Gas Co., Trinidad, Colo., and was active in the design and construction of its steam plant at Walsenburg, Colo. In July, 1912, he entered the engineering department of the Electric Bond & Share Co., which took up at that time the development of the Utah Power & Light Co. After working on designs for 130,000-volt switching and substations and transmission lines, he went to Utah as engineer on the construction of these projects and later became assistant chief engineer of the Utah Power & Light Co.

In the fall of 1916, feeling that the United States should take its stand for justice in world affairs and could not long hold aloof, Mr. Damon decided to enter the Engineer Reserve Corps of the Army, and subsequently received a commission as captain. He was ordered to Fort Leavenworth for training Oct. 1, 1917, and in December was attached to the 114th Engineers at Camp Beauregard, Louisiana. Early in January, 1918, Captain Damon was relieved from duty with the 114th Engineers and detailed to the Power Section of the War Industries Board. In this capacity he was assigned to make studies of and recommendations for the power supply in several of the heaviest industrial districts of the east, including Philadelphia, Baltimore, Lancaster, Pittsburgh and Eastern Ohio, and the New England States. In September, 1918, Captain Damon was placed in charge of the development and control of the power supply in the Pittsburgh and Eastern Ohio District, and in the following month was promoted to the rank of major.

Major Damon is a member of the American Institute of Electrical Engineers and of other engineering societies.

Obituary.

E. H. JACOBS, construction engineer and superintendent of all distribution lines of the Western States Gas & Electric Co., at Stockton, Cal., died of pneumonia on Jan. 16, after having been ill with influenza for about ten days. Mr. Jacobs had been connected with the Western States company for ten years, and for the last seven years had been located at Stockton.

ABRAM T. BALDWIN, president and general manager of the Precision Instrument Co., Detroit, Mich., died suddenly from heart disease at the American House, Boston, on Jan. 8. Mr. Baldwin was born in Yonkers, N. Y., on Sept. 26, 1870, and was educated in the public schools of that city. After his graduation from Cornell University, he went to the William A. Sweet Rolling Mills, Syracuse, N. Y., where he served apprenticeship in every branch of the industry. In January, 1895, Mr. Baldwin became connected with the Solvay Process Co., Syracuse, N. Y., working in various departments and subsequently becoming assistant manager of the soda ash department. After serving in this capacity for some time he left Syracuse to enter the coke department of Solvay Process Co., Detroit, Mich. When the Precision Instrument Co. was organized in May, 1910, Mr. Baldwin became interested in that organization, but did not devote his entire time to its affairs until 1911 when he became treasurer. In 1913 he was made president and general manager of the company to which h ehas given his undivided attention. He was deeply interested in the combustion of coal and efficiency of boiler operation. When the United States entered the war, Mr. Baldwin was asked to take up the manufacture of air speed indicators for the Bureau of Aircraft, Science and Research Division, and it is believed that the strenuous efforts exerted by him in this connection resulted in the physical breakdown and his untimely death. Mr. Baldwin was a life member of the American Society of Mechanical Engineers, a member of the Detroit Engineering Society, National Association Stationary Engineers, American Gas Institute and a number of other organizations.

For the Readjustment Period—What?

XXIV.

Let every electrical manufacturer, who can possibly arrange to do so, be represented at the Chicago convention. Any information or assistance desired will be gladly rendered by the undersigned in behalf of the local committee. This is a big thing. Help us to carry it through in a big way.

C. A. TUPPER, *President* — CHICAGO, INTERNATIONAL TRADE PRESS, Inc.

Getting Together

The Sixth National Foreign Trade Convention, which is to be held in Chicago on April 24, 25 and 26, promises to be the most interesting and largely attended, as well as the most important of all the series of conventions which the National Foreign Trade Council has held.

The sudden ending of the war has brought the country face to face with the problem of maintaining our present prosperity and standards of living. To do this our war industries must be converted, our fighters must be employed, our surplus products and capital must find foreign outlets, and our newly built shipping must be operated in accord with a sound national maritime policy.

It is clearly recognized by all factors of our commercial and industrial life, that the need of this country for expanding our foreign trade has never been so great as it will be in the period which we are now entering. The one question which acutely concerns these interests is HOW this expansion may be achieved and maintained. The chief function of the Sixth National Foreign Trade Convention will be to answer that question.

The Convention will be peculiarly well equipped to make the answer. It will be composed of men who are the actual, practical leaders of the foreign trade of the United States. Every agency of productive enterprise in this country—agricultural, commercial, financial, industrial, labor and transportation—will take part in the convention through its leading representatives. There will be delegates from every section of the country.

Concerted action is needed to meet the present uncertainty of the foreign trade situation. This can best be attained by assembling representative men from all lines of business, obtaining from them their expert opinion and then moulding this opinion into a vigorous policy, to prevent depression during the transition period. That is what the Sixth National Foreign Trade Convention is expected to accomplish.

Financial News

Annual Report of Brooklyn Edison Co.

The annual report of the Brooklyn Edison Co., Inc., formerly the Kings County Electric Light & Power Co., for the year ending Dec. 31, 1918, has been made public and shows that the company has attained satisfactory results during the second war year, considering the constantly advancing prices of materials and supplies, inferior quality of coal received, increase in wages, shifting and drafting of employes, advance in taxes and the effect of the so-called lightless nights and workless days and daylight saving.

The results have been largely attained through the loyal support of the management by an energetic and patriotic corps of employes. Every endeavor was made to help win the war and at the same time promote the conservation of capital. The sales force was reduced to a minimum, and devoted its time in attending the needs of the Government, furthering the development of essential war industries, and obtaining additional business from existing customers, thereby augmenting the revenue of the company with a minimum of expense.

Contracts were signed for 52,000 hp., and included installations for shipyards; the great army and navy bases at South Brooklyn, manufacture of torpedoes, ammunition, gyroscopes, stabilizers, searchlights, gas-mask parts, shoes, uniforms, food products and various other war necessities. Twenty-five thousand kw. additional capacity with necessary auxiliaries was installed in the generating stations and with a corresponding amount of substation apparatus the company was able to keep pace with the demands for service and to take care of all requirements.

Much time and study was given during the year to working out a plan for the future financing of the company. The directors finally determined that the most practical plan would be for the company to merge into and with itself the Edison Electric Illuminating Co. of Brooklyn and with the consent of the stockholders to execute a mortgage securing an issue of bonds. This was done after securing the necessary consents from the governmental authorities and parties interested. $5,500,000 bonds were issued and are now being offered to the public by the Guaranty Trust Co. at 91 and interest.

One change took place in the board of directors, George B. Gallagher being elected to fill the vacancy created by the death of his father, Bernard Gallagher, who had served the company for over 17 years.

Continued loyalty to the city, state and national governments is evidenced by the record of the company and its employes. Upwards of 375 former employes were active in the Federal service.

Throughout the year the primary ideal of the company has been to co-operate in every way possible toward the winning of the war and to render a distinctly first-class service to its patrons, despite unusual and often trying conditions.

The indications are that the present year will see to a large extent the transition throughout the country generally from a war to a peace basis, but the company will, it is believed, be able to adjust itself to the changing conditions.

Rockford Electric Bond Issue Authorized.

The Rockford Electric Co., Rockford, Ill., has been authorized by the Illinois Public Utilities Commission to issue first and refunding 5% gold bonds to the amount of $164,000. The Commission has also issued an order authorizing the same company to issue preferred stock in the aggregate amount of $66,000. The Western United Gas & Electric Co. of Aurora has been authorized to issue $155,000 of general mortgage gold bonds and $1,500,000 guarantee debenture notes. The Aurora, Plainfield & Joliet Railway Co. was given permission by the Illinois Commission to issue $200,000 of first mortgage 5% gold bonds.

Two Utility Companies Defer Interest Payment.

Two utility companies yesterday deferred payment on their Jan. 1 interest. One was the New Orleans Railway & Light Co., whose 4½% general mortgage bond coupon was due. The company has had hard sledding for some time, owing to high operating costs, and was first rejected when it applied to the War Finance Corporation for a loan, but afterward was lent $1,000,000 to effect the extension of its one year notes. These are due June 1. The other company to defer payment was the Indianapolis Street Railway Co., which did not meet interest on its 4% bonds.

Dividends.

The board of directors of the Brooklyn Edison Co. has declared a regular quarterly dividend of $2.00 per share on the amount of the capital stock outstanding, payable March 1, to stockholders of record Feb. 14.

Tampa Electric Co. has declared a cash dividend of $2.50 per share, payable Feb. 15 to stock of record Feb. 7.

Earnings.

COLUMBIA GAS & ELECTRIC.

Preliminary statement of the consolidated earnings of the Columbia Gas & Electric Co. and subsidiaries shows:

For December—	
Gross earnings	$1,123,834
Operating expenses and taxes	507,102
Net operating earnings	616,741
Other income	167,755
Total net earnings	784,497
Lease rentals, etc.	293,210
Fixed charges, Columbia Gas & Electric	59,445
Surplus	430,841

INTERBOROUGH RAPID TRANSIT.

For November—	1918.	1917.
Gross	$3,435,687	$3,454,687
Net after taxes	1,090,619	1,554,618
Total income	1,776,667	1,782,300
Surplus after charges.	239,822	685,035
For the 5 months ended Nov. 30—		
Gross	16,170,935	15,928,087
Net after taxes	4,730,496	6,009,407
Total income	7,670,446	8,145,851
Surplus after charges.	493,963	2,765,798

GENERAL GAS & ELECTRIC CO.
(Subsidiaries.)

Statement of estimated gross revenue for December, 1918 and 1917, and comparison:

System.	1918.	1917.
Rutland	$ 44,137.05	$ 49,828.98
Northwestern Ohio	25,096.55	25,214.85
Sandusky	53,385.12	57,726.87
Binghamton	40,356.94	34,929.12
Sayre	12,651.25	15,642.10
New Jersey	29,883.18	21,210.28
Interurban Gas Co.	887.97	720.83
Totals	$206,398.06	$205,273.03

CITIES SERVICE COMPANY.

	Month of Nov., 1918.	Month of Nov., 1917.
Gross earnings	$1,821,533.36	$1,732,412.56
Expenses	50,923.87	30,050.53
Net earnings	$1,770,609.49	$1,702,362.03
Interest on debentures	51,604.73	208.97
Net to stock	$1,719,004.76	$1,702,153.06
Dividends preferred stock	337,201.00	327,585.00
Net to common stock and reserves	$1,381,803.76	$1,374,568.06

WEEKLY COMPARISONS OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeller & Co., Rookery Bldg., Chicago.

Public Utilities—	Div. rate. Per cent.	Bid Feb. 7.	Bid Feb. 14.
Adirondack Electric Power of Glens Falls, common	6	11	10
Adirondack Electric Power of Glens Falls, preferred	6	68	70
American Gas & Electric of New York, common	10+extra	98	98
American Gas & Electric of New York, preferred	6	43	43
American Light & Traction of New York, common	..	234	237
American Light & Traction of New York, preferred	6	98	98
American Power & Light of New York, common	4	56	57
American Power & Light of New York, preferred	6	75	75
American Public Utilities of Grand Rapids, common	..	..	..
American Public Utilities of Grand Rapids, preferred	7	35	34
American Telephone & Telegraph of New York	..	99½	100⅞
American Water Works & Elec. of New York, common	..	4	4
American Water Works & Elec. of New York, particip	7	10	10
American Water Works & Elec. of New York, first preferred	..	65	58
Appalachian Power, common	..	1	2
Appalachian Power, preferred	7	12	13
Cities Service of New York, common	+extra	312	316
Cities Service of New York, preferred	6	80	80½
Commonwealth Edison of Chicago	8	113½	112
Comm. Power, Railway & Light of Jackson, common	..	19	19
Comm. Power, Railway & Light of Jackson, preferred	6	40	41
Federal Light & Traction of New York, common	..	8	8
Federal Light & Traction of New York, preferred	..	39	39
Illinois Northern Utilities of Dixon	6	..	..
Middle West Utilities of Chicago, common	2+extra	20	20
Middle West Utilities of Chicago, preferred	6	50	50
Northern States Power of Chicago, common	..	62	65
Northern States Power of Chicago, preferred	ex.div.7	89	90
Pacific Gas & Electric of San Francisco, common	..	50	48
Pacific Gas & Electric of San Francisco, preferred	6	85	..
Public Service of Northern Illinois, Chicago, common	7	90	88
Public Service of Northern Illinois, Chicago, preferred	6	90	88
Republic Railway & Light of Youngstown, common	4	16½	16
Republic Railway & Light of Youngstown, preferred	6	52	53
Standard Gas & Electric of Chicago, common	..	13½	27
Standard Gas & Electric of Chicago, preferred	6	31	43
Tennessee Railway, Light & Power of Chattanooga, common	..	2½	2½
Tennessee Railway, Light & Power of Chattanooga, preferred	6	13	12
United Light & Railways of Grand Rapids, common	4	36½	36½
United Light & Railways of Grand Rapids, preferred	6	68	68
Western Power of San Francisco, common	..	18½	18½
Western Union Telegraph of New York	extra	86⅜	87
Industries—			
Electric Storage of Philadelphia, common	4	52½	55½
General Electric of Schenectady	8	148	146½
Westinghouse Electric & Mfg. of Pittsburgh, common	7	41	41
Westinghouse Electric & Mfg. of Pittsburgh, preferred	7	55	55